PROPERTY OF
DENTAL LIBRARY
UNIVERSITY OF MICHIGAN
copy 4
JUN 30 1930
DON'T MUTILATE OR REMOVE

Volume X June, 1930 Number 3

THE JOURNAL OF DENTAL RESEARCH

(Continuing the Journal of the Allied Dental Societies)

EDITED BY

J. L. T. Appleton, Jr., Philadelphia
Elmer S. Best, Minneapolis
Theodore B. Beust, Louisville
Arthur D. Black, Evanston
James R. Blayney, Chicago
C. F. Bödecker, New York City
R. W. Bunting, Ann Arbor
H. E. S. Chayes, New York City
Frank Colyer, London
Kaethe W. Dewey, Pittsburgh
Martin Dewey, New York City
F. N. Doubleday, London
Wm. B. Dunning, New York City
Henry W. Gillett, New York City
Bernhard Gottlieb, Vienna
William K. Gregory, New York City
Edward H. Hatton, Chicago
Milo Hellman, New York City
Percy R. Howe, Boston
Thaddeus P. Hyatt, New York City
Philip Jay, Ann Arbor
E. V. McCollum, Baltimore
Frederick S. McKay, New York City
John A. Marshall, San Francisco
Arthur H. Merritt, New York City
L. M. S. Miner, Boston
Frederick B. Noyes, Chicago
Balint Orban, Vienna
Weston A. Price, Cleveland
Theodor Rosebury, New York City
F. E. Rodriguez, Washington
Kurt H. Thoma, Boston
M. L. Ward, Ann Arbor
B. W. Weinberger, New York City
Wm. H. Welker, Chicago
J. Leon Williams, New York City

AND BY REPRESENTATIVES OF AFFILIATED SOCIETIES

First District Dental Society of the State of New York (which in 1906 established the Journal of the Allied Dental Societies, now the oldest non-commercial journal in dentistry): John Oppie McCall
New York Academy of Dentistry: Malcolm W. Carr
Robert R. Andrews Society for the Promotion of Research (Tufts): Charles E. Hatch
Harriet Newell Lowell Society for Dental Research (Harvard): Harold E. Tingley
William Jarvie Society for Dental Research (Columbia): Joseph Schroff
Dental Educational Council of America: H. E. Friesell, Pittsburgh
American College of Dentists: Albert L. Midgley, Providence

International Association for Dental Research—

Sections (Secretaries):

Ann Arbor—U. G. Rickert
Boston—Fred R. Blumenthal
Chicago—Stanley D. Tylman
Cleveland—Samuel W. Chase
Halifax—George K. Thomson
Minnesota—Carl W. Waldron
New Haven—Wm. G. Downs, Jr.
New York—Bissell B. Palmer
Philadelphia—Carrie Kirk Bryant
Pittsburgh—Lawrence E. Van Kirk
St. Louis—Clarence O. Simpson
San Francisco—John S. Shell
Toronto—A. J. Broughton
Vienna—Emerich Kotanyi
Winnipeg—E. Roy Bier

Association (General Secretary): William J. Gies, *Executive Officer of the Board of Editors*

PUBLISHED BI-MONTHLY
AT MT. ROYAL AND GUILFORD AVENUES, BALTIMORE, MD.
BY THE JOURNAL OF DENTAL RESEARCH, INC.
Editorial Office 632 West 168th St., New York City
Copyright, 1930, by the Journal of Dental Research, Inc.

Entered as second-class matter June 24, 1919, at the Post Office at Baltimore, Maryland under the act of March 3, 1879

Made in United States of America

Important Books Received

An outline of oral surgery for the general dental practitioner. By James L. Zemsky, D.D.S., Attending Oral Surgeon to the Midtown Hospital, New York. 1930: pp. 171; 6 ¾ x 4 in.; 116 illustrations; $4.50. Physicians and Surgeons Book Co., Brooklyn, N. Y.

Oral diseases: a practical treatise offering diagnostic and therapeutic aid to the practitioner of medicine and dentistry. By James L. Zemsky, D.D.S., Attending Oral Surgeon to the Midtown Hospital, New York. 1930: pp. 402; 6¾ x 4 in.; 414 illustrations; $8.00. Physicians and Surgeons Book Co., Brooklyn, N. Y.

Necrotic gingivitis (trench mouth). By Harold Keith Box, D.D.S., Ph.D., Research Professor of Periodontology, Faculty of Dentistry, University of Toronto. 1930: pp. 64; 7 x 4½ in.; 18 illustrations. University of Toronto Press, Toronto, Canada.

Medical education and related problems in Europe. By Willard C. Rappleye, Director of the Study by the Commission on Medical Education. 1930: pp. 200; 7½ x 4 in.; no illustrations. Published by the Commission, 215 Whitney Ave., New Haven, Conn.

Those teeth of yours. By J. Menzies Campbell, L.D.S., D.D.S., F.R.S.E., F.I.C.D., Fellow of the Royal Society of Medicine. 1929: pp. 141; 5½ x 3½ in.; 17 illustrations; 3/6 net. William Heinemann, Ltd., 99, Great Russell St., London, W.C.I., England.

Infant nutrition. By Williams McKim Marriott, B.S., M.D., Professor of Pediatrics, School of Medicine, Washington University. 1930: pp. 375; 7¾ x 4¾ in.; 55 illustrations; $5.50. C. V. Mosby Company, St. Louis, Mo.

Public health aspects of dental decay in children. Number III of School Health Research Monographs. By Raymond Franzen, Ph.D., Director of Research, School Health Study, American Child Health Association. 1930: pp. 121; 7 x 4½ in.; 2 charts, 10 graphs, and many tables. American Child Health Association, New York.

Rickets including osteomalacia and tetany. By Alfred F. Hess, M.D., Clinical Professor of Pediatrics, University and Bellevue Hospital Medical College, New York City. 1929: pp. 485; 7½ x 4 in.; 52 illustrations; $5.50. Lea and Febiger, Philadelphia, Pa.

Synopsis of the practice of preventive medicine as applied in the basic medical sciences and clinical instruction at the Harvard Medical School. By the Faculty of Medicine. 1929: pp. 194; 6½ x 3¾ in.; no illustrations. Harvard University Press, Cambridge, Mass.

The properties and uses of drugs. By Henry H. Rusby, Ph.M., M.D., D.Sc., Dean and Professor of Materia Medica, College of Pharmacy, Columbia University; A. Richard Bliss, Jr., A.M., Phar. D., M.D., Dean of the School of Pharmacy, and Chief of the Division of Pharmacology and Materia Medica, Colleges of Medicine and Dentistry and School of Pharmacy, University of Tennessee; and Charles W. Ballard, A.M., Phar. D., Ph.D., Associate Professor of Materia Medica and Director of the Microscopical Laboratory, College of Pharmacy, Columbia University. 1930: pp. 823; 7¾ x 4¾ in.; 38 illustrations; $6.50. P. Blakiston's Son and Co., Philadelphia.

American illustrated medical dictionary. A complete dictionary of the terms used in medicine, surgery, dentistry, pharmacy, chemistry, nursing, veterinary science, biology, medical biography, etc. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., member of the Committee on Nomenclature and Classification of Diseases, American Medical Association, and Editor of the "American Pocket Medical Dictionary"; with the collaboration of E. C. L. Miller, M.D., Professor of Bacteriology and Biochemistry, Medical College of Virginia. *Fifteenth edition.* 1929: pp. 1427; 8½ x 4¾ in.; 525 illustrations; flexible binding—plain, $7.00; thumb index, $7.50. W. B. Saunders Company, Philadelphia and London.

Dental bibliography. A reference index to the literature of dental science and art as found in the Libraries of the New York Academy of Medicine and Bernhard Wolf Weinberger. Compiled by Bernhard Wolf Weinberger, D.D.S., Librarian of the First District Dental Society; Advisory Librarian, Dental Library, New York Academy of Medicine. *Second edition.* 1929: pp. 183; 7½ x 4½ in.; no illustrations. Published under the auspices of the First District Dental Society of the State of New York, New York City.

Deutsche Zahnheilkunde. Heft 75. 1929: 8 x 4½ in.; marks 3.60. Georg Thieme, Leipsig, Germany. (1) Submaxillare Röntgenaufnahmen, ein neues Verfahren zur röntgenographischen Darstellung des Unterkiefers und seiner Zahne. By Dr. J. v. Reckow, Marburg. Pp. 15; 30 illustrations. (2) Klinik und Diagnostik der Osteodystrophia fibrosa localisata der Kiefer. By Dr. Karl Spring, Vienna. Pp. 15; 7 illustrations.

Fundamentals of pathology. By Joseph Schroff, B.S., M.D., D.D.S., Associate Professor of Oral Pathology, School of Dental and Oral Surgery, Columbia University. 1929: pp. 109; 7½ x 4½ in.; 40 illustrations; $2.50. William Albert Broder, New York City.

Outline of bacteriology. By Henry A. Bartels, B.S., D.D.S., Lecturer on Bacteriology, School of Oral Hygiene, Columbia University. 1929: pp. 128; 6¾ x 4 in.; 47 illustrations; $2.00. William Albert Broder, New York City.

Dental histology and embryology. By B. Orban, M.D., Professor of Dental Histology and Pathology, Chicago College of Dental Surgery, Dental Department of Loyola University. *Second edition.* 1929: pp. 218; 7 x 4½ in.; 201 illustrations; $4.00. P. Blakiston's Son and Co., Inc., Philadelphia.

Four lectures on "local analgesia in dental practice." Delivered, under the auspices of the Dental Board of the United Kingdom, by C. H. Howkins, F. N. Doubleday, F. St. J. Steadman, and A. T. Pitts. 1929: pp. 119; 7¾ x 4¾ in.; 104 illustrations. Dental Board of the United Kingdom, 44 Hallam Street, Portland Place, London, W. I.

Practical conclusions from scientific research in denture construction. By Alfred Gysi, D.D.S., M.D. (hon.), D.M.D. (hon.), Professor of Prosthetic Dentistry and Director of the Histological Laboratory, University of Zurich, Switzerland. 1929: pp. 40; 7¾ x 4¾ in.; 37 illustrations. Dentists' Supply Company of New York.

The business side of dentistry. By Edwin N. Kent, D.M.D., Lecturer on conduct of practice, Harvard University Dental School. 1929: pp. 180; 6¾ x 4 in.; 13 illustrations; $5.00. C. V. Mosby Co., St. Louis, Mo.

A text-book of oral pathology for students and practitioners of dentistry. By Russell W. Bunting, D.D.S., D.D.Sc., Professor of Dental Histology and Pathology, University of Michigan, Ann Arbor, Michigan. 1929: pp. 495; 7¾ x 4½ in.; 327 illustrations; $7.00. Lea and Febiger, Philadelphia, Pa.

Hygiene of the mouth and teeth. By Thaddeus P. Hyatt, D.D.S., F.A.C.D., Professor of Preventive Dentistry, New York University Dental School, and Assistant Medical Director, Metropolitan Life Insurance Company. 1929: pp. 64; 4½ x 2¾ in.; 1 illustration. Brooklyn Dental Publishing

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

SCIENTIFIC PROCEEDINGS OF THE CHICAGO SECTION[1]
FEBRUARY 26, 1930

STANLEY D. TYLMAN, B.S., D.D.S., F.A.C.D., *Editor*

Meeting held at the Medical and Dental Arts Club, 185 N. Wabash Ave., Chicago, February 26, 1930. *Chairman*: Edward H. Hatton, B.L., M.D., President of the Section.

Scientific program

I. A case of metastatic carcinoma of the jaw bone. *Wm. G. Skillen*, D.D.S.... 247
II. Presentation of a specimen showing the repair of a previously diseased root-end after ten years, following root-canal treatment. *J. R. Blayney*, B.S., D.D.S., M.S.... 248
III. The progress of dental caries in its relation to enamel lamellae and interglobular spaces. *F. J. Barker*, D.D.S.... 249
IV. Report on cases of beginning cancer of the lower lip. *Rudolf Kronfeld*, M.D.. 249
V. Normal characteristics of the gingiva and their relation to pathology. *Wm. G. Skillen*, D.D.S.... 250

ABSTRACTS

I. A CASE OF METASTATIC CARCINOMA OF THE JAW BONE

Wm. G. Skillen, D.D.S., Department of Histology, Northwestern University Dental School, Chicago, Illinois

Case history: Female, 40 years of age; carcinoma of the breast and anemia. Histological examination of the jaws revealed an extensive involvement of both jaws, particularly at the ends of the roots of the teeth. Only the incisor region escaped. There was a large amount of bone destruction, and only a small amount of compensatory new formation usually poorly calcified. While tumor cells occupied resorption lacunae, and osteoclasts were very few in number, the writer is inclined

[1] The last preceding series of abstracts of the proceedings of the Chicago Section was published in the *Journal of Dental Research*, 1930, x, p. 133.

to support Axhausen in his view that the tumor cells play no direct rôle in the resorption process, but simply occupy already-formed lacunae. Circulatory vessels were found fairly occluded by tumor cells. In contrast to the bone, no tooth resorption was noted, even though tumor cells had invaded the peridental membrane. On its periphery the tumor was of the scirrhous type; but with the great increase in tumor cells toward the deeper portion, it assumed the appearance of a fibro-medullary type.

II. PRESENTATION OF A SPECIMEN SHOWING THE REPAIR OF A PREVIOUSLY DISEASED ROOT-END AFTER TEN YEARS, FOLLOWING ROOT-CANAL TREATMENT

J. R. Blayney, B.S., D.D.S., M.S., Dental School, University of Illinois, Chicago, Illinois

This report is based upon the histologic study of material obtained one and ten years, respectively, after root-canal treatment. Before clinical treatment had been instituted, the pulps in both cases were necrotic, and radiolucent areas were present about the root-ends.

In the first case, a lower molar, the radiogram showed a complete regeneration of bone about the distal root at the time of extraction, one year after treatment. On histologic examination of the soft tissue about the apex, we found that the granuloma which existed prior to treatment was undergoing a marked change. The central mass of inflammatory cells was being replaced by young fibro-blasts and many newly-formed blood vessels. The entire area was rapidly returning to a satisfactory condition.

In the second case, an upper bicuspid, the radiogram showed a complete regeneration of bone surrounding the apex ten years after treatment. The histological examination revealed the entire apical periodontal membrane to be free from inflammation where a granuloma had previously existed. The lumen of the unfilled apical portion of the canal had been materially reduced in size by a deposit of cementum. The soft tissue contained within the lumen of the canal was fibrous and free from inflammation. This fibrous tissue is a repair tissue, which was formed as the inflammation subsided. The apical portion of the gutta-percha was enclosed by repair cementum.

III. THE PROGRESS OF DENTAL CARIES IN ITS RELATION TO ENAMEL LAMELLAE AND INTERGLOBULAR SPACES

F. J. Barker, D.D.S., Chicago College of Dental Surgery, Loyola University, Chicago, Illinois

Dental caries progresses in the direction where it meets the least resistance. Therefore, its path is predetermined by the varying degree of calcification in the tooth structures. Caries usually follows the course of the enamel lamellae from the surface of enamel, and from the bottom of fissures, toward the dento-enamel junction. This is shown in both ground and decalcified sections. In its progress along the dentinal tubuli, the infection reaches the poorly calcified areas in the dentin, known as interglobular spaces. There the caries spreads out very rapidly. Interglobular spaces may be infected and decayed long before the destruction of the well-calcified dentin around it has taken place.

IV. REPORT ON CASES OF BEGINNING CANCER OF THE LOWER LIP

Rudolf Kronfeld, M.D., Chicago College of Dental Surgery, Loyola University, Chicago, Illinois

The material for this study was taken from two cases of cancer which had been operated upon by Dr. W. H. G. Logan. The tissue obtained in the operation consisted of a wedge-shaped piece of lower lip, the cancer being on the upper side of the specimen. In one case, the cancer appeared as a hard, wart-like knob on the surface of the lip; in the other, there was a shallow depression formed by a cancerous ulcer. The surrounding tissue was hard and infiltrated.

Histologically the first case showed an abundant hornification of the superficial layers, forming high projections and papillae of horn; the deeper layers of epithelium manifested a tendency to proliferate into the underlying connective tissue. Mitosis was plentiful in the epithelium. In the other case there was a defect in the epithelium about the size of a cent. From the base of this chronic ulcer there was a proliferation of epithelium into the connective tissue of the lip.

V. NORMAL CHARACTERISTICS OF THE GINGIVA AND THEIR RELATION TO PATHOLOGY

Wm. G. Skillen, D.D.S., Department of Histology, Northwestern University Dental School, Chicago, Illinois

The present report is a sequel to one entitled, "The morphology of the gingivae of the rat molar," which will appear in an early issue of the *Journal of the American Dental Association*. Whereas that article describes conditions on the buccal and lingual surfaces only, this report embraces a study of the interproximal gingiva, between which and the former there is a difference of pathological importance. It shows, further, that characteristics similar to those in the rat may be observed in the dog, but with one important difference also of significance in pathology. The two reports support the contentions of Becks[2] relative to the changes that occur in the gingiva, but give the details of these changes, which Becks omitted.

The report shows that degeneration of the entire epithelial attachment, proliferation of the mouth epithelium to replace the former, and a shifting of epithelial attachment and gingiva apexwise, are changes normally characteristic of the gingiva, at least on the buccal and lingual surfaces. It is further shown, however, that in the interproximal area, in the rat, there is no mouth epithelium to replace the epithelial attachment which, because of its anatomical arrangement, is more subject to degeneration than on other surfaces. It is also pointed out that the proliferating mouth epithelium in the dog does not keratinize, whereas in the rat this is one of the most important changes. The relation these changes bear to pathology is pointed out. How the degenerating epithelial attachment on all surfaces of the tooth, and particularly in the interproximal area, is subject to infection and necrosis, is indicated; also how the well-keratinized mouth epithelium in the rat serves to protect the sub-epithelial structures, while in the dog, where that layer does not form, protection is lessened. The report also shows the effects of injury which, producing intra-epithelial tears, exposes to infection a degenerating epithelial-attachment that lacks protective qualities. Finally, it intimates that the conditions characteristic of the human are more comparable with those of the dog than of the rat, and that therefore the human is more subject to pathological involvement.

[2] Becks: *Journal of the American Dental Association*, 1929, xvi, p. 2167.

SOME USES FOR DISSOLVED CELLULOID IN THE PREPARATION OF GROUND SECTIONS OF BONES AND TEETH[1]

SAMUEL W. CHASE, PH.D.

Laboratory of Histology and Embryology, Western Reserve University, Cleveland, Ohio

CONTENTS

I. Dissolved celluloid as an adhesive during the process of grinding and polishing. 251
II. Dissolved celluloid as an advantageous substitute for balsam in the Koch petrifaction method..... 252
III. Dissolved celluloid as a substitute for celloidin in the White method..... 254
IV. Literature cited..... 254

I. DISSOLVED CELLULOID AS AN ADHESIVE DURING THE PROCESS OF GRINDING AND POLISHING

Although some degree of success has been attained with the use of various substances [e.g., casein glues such as collolith (Meyer, '25), or glyptol, and shellac], Canada balsam has been the most commonly employed adhesive for affixing specimens to a mount during the processes of grinding and polishing thin sections. Balsam is, however, difficult to use [Black ('29), p. 437; Patten and Chase ('25), p. 136–137], and unsatisfactory in certain respects. It is difficult to prepare and maintain at the proper consistency; various lots of balsam differ in properties; balsam-affixed specimens must be ground in the presence of a stream of ice-water to avoid melting the balsam by the heat of friction; balsam rapidly fills and clogs the surface of the wheel or hones; because of the foregoing factors, it is never certain that the specimen will remain affixed throughout the grinding process.

During the past six months the writer has used an adhesive cement composed of dissolved celluloid in place of Canada balsam, and finds it much more satisfactory. The cement may be made by simply dissolving clear celluloid in acetone until the consistency is that of table syrup, or a better and more convenient cement may be bought

[1] Conducted with the aid of a grant from the Scientific Foundation and Research Commission of the American Dental Association. Reported in part at a session of the Eighth General Meeting of the International Association for Dental Research: *Journal of Dental Research*, 1930, x, p. 401.

in tubes under the name of Dupont's Household Cement. This adhesive has several advantages over balsam: it is easily and inexpensively procured and kept; it is uniform in quality; specimens affixed by it may be ground in the presence of water at room temperature; it does not fill and clog the surface of the wheel or bone as rapidly as does balsam; one can be practically certain that the specimen will remain attached to the mount throughout the grinding process, if the cement is properly used. The following technique for the use of "Household Cement" is employed in this laboratory:

1. Fix the specimen or not as desired.
2. Grind and polish one face of the specimen at the desired plane of section.
3. Clean the polished surface with water, rubbing gently with a cloth free from lint.
4. Dehydrate the specimen: 20 to 60 minutes each in 35, 50, 70, and 95 per cent alcohols.
5. Acetone: 20 to 60 minutes.
6. Apply a thin film of Dupont's Household Cement to the clean surface of the grinding-mount.
7. Rapidly apply a similar film to the polished surface of the specimen.
8. Quickly press the specimen on the mount, using a slight rotary motion to ensure uniform union of the two films.
9. Immediately plunge the mounted specimen into chloroform, where it should remain for at least 30 minutes.
10. Grind and polish in the constant presence of water.
11. Polished thin section on mount to 95 per cent alcohol: 5 to 10 minutes.
12. Free the section from the mount by soaking in acetone. Wipe gently to clean.
13. Place the freed section in xylol: 5 to 10 minutes.
14. Mount in Canada balsam.

Note. Stains or other treatment may be applied between steps 10 and 12, or between 3 and 5.

II. DISSOLVED CELLULOID AS AN ADVANTAGEOUS SUBSTITUTE FOR BALSAM IN THE KOCH PETRIFACTION METHOD

Since Koch ('74) first described the method of obtaining ground sections of calcified and soft tissues by including them in a hard matrix

of Canada balsam before grinding, the method has undergone but minor modifications. Koch himself ('78) experimented with the use of other gums, such as sandarac, gum arabic, and copal, but balsam has remained the gum of choice for the method.[2]

The following modification of the petrifaction method, using celluloid in place of balsam, has several advantages. (a) It is more rapid, requiring only days instead of weeks [though, as Röse ('92) has shown, too much celerity is undesirable]. (b) It is not necessary to grind the specimen in the presence of ice-water. (c) The celluloid does not clog the stones used in grinding and polishing as rapidly or as much as does balsam. The procedure used by the writer is indicated below:

1. Fix the part from which the section is to be taken as desired.
2. Wash according to the method of fixation used, and bring to a syrupy aqueous solution of gum arabic (or dextrin).
3. Freeze on the freezing chamber of a freezing microtome.
4. Cut a thin slice, or slices, using a very fine saw. [Williams ('27) advises the use of a fine jeweler's saw].
5. Wash the slice in water to remove the gum arabic.
6. Stains which can be applied *in toto* may be used here (e.g., carmine, haematoxylin, etc.).
7. Ascending alcohol series to 95 per cent: 30 minutes to several hours each, according to the size of the slice.
8. Acetone: 30 minutes or more.
9. Place in a thin solution of celluloid (about the consistency of table syrup), using a depth of solution at least twice the thickness of the slice. A very convenient form of dissolved celluloid is the clear celluloid lacquer obtainable at any paint-store, e.g., Duco, clear; Rogers Brushing Lacquer, clear; etc.
10. Leave the container open a mere crack, and allow the solvent of the lacquer to evaporate slowly at room temperature, until it will scarcely flow when the container is tilted steeply; then remove the slice with a considerable amount of surrounding celluloid solution to a smooth flat sheet of heavy lead-foil [Bödecker ('26) forms the container of lead-foil], and allow to evaporate further until the celluloid matrix is completely hardened.

[2] Weil's ('87) more rapid evaporation of the balsam solvent was not an improvement of Koch's method, as Röse ('92) has pointed out, and does not justify the usual practice of calling the method the Koch-Weil method. Christensen erred in ascribing the method to Weil (*Dental Cosmos*, 1894, 36: 284–290).

11. Grind and polish one face of the slice (in the presence of water) to the desired plane of section. Wash and wipe clean.

12. Attach to grinding-mount with "Household Cement" as described in Part I of this paper.

13. Grind and polish the section to the desired thickness (in the presence of water). Wash and wipe clean.

14. Soak in acetone to remove the celluloid, and transfer to slide.

15. Flood with xylol to remove acetone.

16. Mount in Canada balsam.

Note. Various staining methods may be applied by the drop method between steps 14 and 16.

III. DISSOLVED CELLULOID AS A SUBSTITUTE FOR CELLOIDIN IN THE WHITE METHOD

The method of T. Charters White ('96) succeeds as well with celluloid as it does with celloidin. The commercial clear celluloid lacquer mixes well with the solution of fuchsin in ether and absolute alcohol.

IV. LITERATURE CITED

BLACK, G. V. 1929 The grinding of microscopic specimens, using the grinding machine In Noyes: Dental histology and embryology, 4th. ed., p. 429–450. Lea & Febiger, New York.

BÖDECKER, C. F. 1926 Fundamentals of dental histology and embryology in diagrammatic drawings and text with appendix of microscopic technique. MacMillan, New York.

KOCH, G. 1874 Anatomie der Orgelkoralle. Habilitationsschrift, Jena. (Cited by Röse, 1892.)

KOCH, G. 1878 Ueber die Herstellung dünner Schliffe von solchen Objecten, welche aus Theilen von sehr verschiedener Consistenz zusammengesetzt sind. *Zool. Anzeiger*, 1:36–37.

MEYER, W. 1925 Die Anfertigung histologischer Schliffe. *Vierteljahrsschr. f. Zahnheilk.*, 41: 113–124.

PATTEN, B. M., and CHASE, S. W. 1925 Simple apparatus for sawing and grinding sections of bone and teeth. *Anat. Record*, 30: 123–138.

RÖSE, C. 1892 Ueber die v. Koch'sche Versteinerungsmethode. *Anat. Anzeiger*, 7: 512–519.

WEIL, L. A. 1887 Zur Histologie der Zahnpulpa. Habilitationsschrift, München.

——— 1891 Bemerkungen zur Histologie der Zahnpulpa, sowie zu der Methode Zähne und Knochen mit conservierten Weichtheilen zu schleifen. *Oesterr.-ungar. Vierteljahrsschr. f. Zahnheilk.*, 7: 18–26.

WHITE, T. C. 1891 A method of infiltrating dental osseous tissues. *Dental Record*, 16: 563–564.

WILLIAMS, A. 1927 The preparation of combined hard and soft tissues for histological study. *Dental Cosmos*, 69: 715–721.

THE PREVENTION OF CARIES AND PERIODONTOCLASIA[1]

PAUL R. STILLMAN, D.D.S., F.A.C.D., F.A.A.P., AND JOHN OPPIE McCALL, A.B., D.D.S., F.A.C.D., F.A.A.P.

College of Dentistry, New York University, New York City

The dental profession is developing an ever increasing interest in the prevention of oral disease. This is evidenced by a number of circumstances, the most prominent and most recent being the decision of Columbia University, as announced in the public press, to conduct a three-year program of research into the "causes of tooth decay and pyorrhea," this research to be supported by a grant from the Commonwealth Fund. The first thought which comes to mind in connection with this announcement is that caries and periodontoclasia do not comprise all of the types of disease which occur in the mouth. It will, however, be agreed probably that either caries or periodontal disease, in its ultimate working out, is the fore-runner of nearly all other oral disturbances. Exceptions are, of course, the oral manifestations of such disease as measles and the other eruptive fevers, and syphilis, which are so distinctly systemic that they do not primarily involve the teeth and their supporting structures except when these are already in a state of disease.

Much thought has been given to this subject, and much investigation has already been carried on in this field. Most of the research has been planned on the assumption that the primary cause of these diseases is a systemic derangement. And it has been held quite generally that this systemic derangement has its basis in dietary defects. Investigators have therefore devoted themselves rather largely to attempts on the one hand to produce dental and periodontal disease in laboratory animals by feeding deficiency diets, and on the other to

[1] Read at a session of the Eighth General Meeting of the International Association for Dental Research, Royal York Hotel, Toronto, Canada, March 24–26, 1930. See abstract: *Journal of Dental Research*, 1930, x, p. 376.

protect children from caries by feeding diets containing presumably protective elements. We may properly include in this category the administration of ultraviolet rays, whose ultimate effect is conceived to be the activation of elements akin to one or more of the vitamins.

At a time when so much attention is being given to diet in the field of prevention, it is impossible to omit discussion of this subject. We believe in the necessity of a correct diet for the development of sound dental and periodontal structures. But we also believe that, having once been formed, the *continued* health of those structures can be maintained only through the local factors we have mentioned elsewhere. Stating a corollary, we believe that health may be maintained in the mouth by these local measures even when there has been a partial inadequacy in structure due to dietary insufficiency.

If diet were all-important in dental health, as some would have us believe, we should expect serious and continuing damage, even in the face of superior local treatment, when so large a proportion of our population eat improperly. Furthermore, dietary deficiencies alone could not produce all the harm we see in contemporary mouths without producing equally striking and serious lesions in the bones or other tissues of the body—and we see neither of these things. On the other hand, if diet is so important, we should expect it to do much for our adult patients, when the supposedly needed dietary corrections are made. Yet here we have had disappointment. It seems highly probable that diet plays its most important part, as far as the teeth and their supporting structures are concerned, in childhood. And the most important period of childhood from this standpoint, as viewed by so careful an observer as Hess, is the first six months of life. He states that as regards vitamin D, the first six months is the only period in which complete protection against rickets can be given. If vitamin D has anything to do with the calcification of the teeth and alveolar process, this is a highly significant statement.

This does not imply a lack of interest on our part in diet as it relates to prevention. But we regard it as unfortunate that many, in such studies, have approached their subject so largely from the standpoint of laboratory research. It may safely be asserted that clinical experience of the broadest and most extensive scope must be a prerequisite to success in the investigation. This clinical experience must also

include a considerable success in the treatment of all phases of oral disease. This experience must also have included careful observation of cases exhibiting the earliest observable departure from health, for the most fruitful clinical observations are those that are intelligently made when disease is just beginning. In other words, we believe that when the patient is just wavering between health and disease, the most valuable observations may be made as to the cause of that imminent departure from health.

This history of investigations into caries and periodontoclasia exhibits a rather striking tendency on the part of most investigators to ignore the fact that clinicians have developed an ability to control entirely both caries and periodontal disease, even when encountered in a fairly well-established stage. It seems not to have been a part of their thought that the methods which have given such success in treatment might also serve as a rational basis for a method of prevention. It would seem to be strange, indeed, if a successful method of treatment of disease did not contain within itself the germ of a successful method of prevention. And it is in the belief that ultimate success in this field can be attained only by the correlation of clinical experience with laboratory investigation that this paper is presented.

There has been a general disposition in the dental profession, both among practitioners and laboratory investigators, to think of caries and periodontal disease as being unrelated lesions. Dentists have come to believe, for instance, that people who are subject to caries are immune to periodontoclasia, and vice versa. From this there has arisen the concept of a dissimilarity in etiology. It has been observed, for instance, that caries is especially prevalent and active in the young, while periodontal disease is notably a lesion of early and middle adult life. The young seldom exhibit serious manifestations of periodontal disease, and likewise the middleaged person, even one who has suffered from caries in his earlier years, seldom develops many new carious cavities. It is natural then to assume that the underlying causative factors of the two processes have little in common. In our observation, however, these two diseases are closely related in etiology, if not in pathologic manifestations. We have noted, in other words, a very close correlation in the young, and even in older patients, between the sites in which caries occur and the location of points of occlu-

sal disharmony. And we have come to believe that there is a causal relationship between traumatic occlusion and caries. Furthermore, in these cases, when the occlusal relations have been improved, there has been a definite cessation of the tendency to caries. We attribute this to two factors: (a) improvement in the circulation in the dental pulp, and (b) improvement in the gingival circulation. Both of these vascular systems are under the direct influence of the pericemental blood supply, and respond to changes induced in the circulation in this tissue. The pericemental circulation, in its turn, is directly influenced by the stimuli of masticatory function, and equally so by the irritation brought about by traumatic occlusion.

Another disease of the hard tissue of the tooth is erosion. This mysterious malady is understood less well than is almost any other oral lesion. Our belief is that here also we have a disease whose etiology is closely related to caries, and in which the etiology follows closely the principle of disturbance of function, and of its influence on pericemental and gingival circulation, which we have already stated. Our reason for reaching this conclusion is the clinical observation repeatedly made that, when we have instituted measures designed to improve function and to take away the burden of irritation, health invariably has returned to all the oral tissues, and disease completely disappeared. And this statement is intended to include erosion as well as caries. Disease and health are not compatible, and when we have one the other is absent. This statement holds regardless of the type of disease.

In the field of periodontal disease our views have been frequently published. And it is only necessary to state here that we believe that the primary factor in the etiology of periodontoclasia is a disturbance of function, the most common manifestation of which is traumatic occlusion.

It will be evident from the foregoing that we have developed a conception of the underlying unity of the etiology of caries and periodontoclasia, based fundamentally on disturbed occlusal relations. That the young individual tends to develop caries as a result of this disturbance is due probably to factors centering in the lymph circulation in the dentine, plus the factors influencing the character of the exudate from the marginal gingiva, each of these being affected by the occlusal load.

The character of the alveolar tissue in most young people is such that it is less severely affected by this irritating influence. But if we follow that young person on into middle life, or if we observe another individual who has been immune to caries, we find in either case a time when the periodontal tissues can no longer withstand the irritation of a continued traumatic occlusion. In this individual, then, we see a breaking down of the periodontal tissues. The only change that has taken place is the acquisition of a certain amount of caries resistance, and a coincidental loss of periodontal resistance. In other words, in the mouths of a large number of people we find, even from the time of the recent eruption of the teeth, a condition of traumatic occlusion. At first this produces an outstanding effect on the dental tissues and much caries results. Later in life the teeth undergo some change, which used to be denoted as increased "hardness," and under the influence of the same traumatic occlusion the periodontal tissues begin to undergo dissolution. This is the philosophy of the unity of the etiology of caries and periodontoclasia which has been developed as the result of years of careful clinical observation. And we feel that it is not too much to assert that this dispassionate study has a real value in the working out of a research into the causes of these lesions.

What are the facts which the clinical research worker can contribute in this investigation? The periodontist has for years noticed several phenomena connected with his work, and apparently basically related to it. In the first place he has found it possible, not only to restore health to the periodontal tissues but also to maintain that state of health indefinitely. Parenthetically it may be noted that the method of treatment referred to is purely local, a point of considerable importance. In the second place, he has observed that, even in mouths previously susceptible to caries, this latter disease wanes or entirely disappears under the influence of the system of treatment instituted for the control of the periodontal disorder. This is a coincidence whose significance cannot be overlooked. The periodontist also notices in these cases that other lesions of the oral cavity, such as certain forms of leukoplakia, lichen planus, etc., disappear during the course of the periodontal treatment. This coincidence also has considerable significance. It is a logical conclusion, therefore, that the measures which have been systematically employed in the treatment of perio-

dontal disease are measures which influence not only periodontal health, but the health of the entire oral cavity. It seems obvious that measures which are successful in suppressing periodontal disease can also be successfully applied in the prevention as well as the eradication of caries and other types of oral disease.

We have frequently published the details of the method of treating periodontal disease that has proven so satisfactory, and it is therefore only necessary to summarize it briefly at this time. Its foundation is the establishment of normal function. This is made up of two parts: (a) bringing all teeth into functioning occlusal contact, if this is by chance lacking; (b) insuring that the teeth shall not function in a harmful manner through those inequalities of stress and those interferences we have termed traumatic occlusion. Traumatic occlusion is much more common than is usually realized. It is found in practically all mouths before natural wear has taken place. Undoubtedly one of the most important reasons why primitive man so commonly escapes the scourge of caries and periodontal disease, is that, through favorable conditions obtaining in childhood, he produces at an early age sufficient natural wear to relieve his dental mechanism of such traumatic occlusion as may have come into existence with tooth eruption. It seems an inevitable conclusion that these changes of tooth form, through wear, have occurred as part of a fundamental natural plan for the preservation of health. Study of the skulls of primitive people brings out very strikingly the fact that those individuals who had the most perfect working occlusion possessed the highest immunity to both caries and periodontoclasia. This statement will hold both for races having a high general immunity and for those which, because of faulty diet or other living conditions, have had an inferior resistance. Observation of these skulls also shows that those individuals who suffered from caries or periodontal disease were invariably subject to an abnormality of occlusal relationships, in the form of malocclusion, loss of teeth, or excessive wear, the latter being quite as important as the other factors mentioned. We believe that this represents a fundamental factor in oral health, which must be given full consideration in any investigation into the causes of oral disease.

Another factor in successful treatment, which seems also to be fundamental in the problem of prevention, is the state of the gingival

circulation. Normally this is directly related to the function of mastication. Gingival circulation is at its optimum in that mouth which enjoys freedom from traumatic occlusion, and in which the dietary habits of the individual make the maximum demands upon the dental mechanism. Where mastication is insufficient through wrong physical character of the food intake, the gingival circulation will be sluggish. On the other hand, where cusp interference occurs and is not relieved by natural wear, pericemental and gingival hyperemia is inevitable. With the development of either of these conditions there ensues, as stated, a derangement of the gingival circulation; and to this derangement can be directly traced many pathologic phenomena, both dental and periodontal. The authority for this statement is the observation, in constant and extensive clinical experience, which may be summed up in the statement that, when appropriate steps are taken for the improvement of the gingival circulation, both dental and periodontal disease are promptly brought under control.

We do not wish to create the impression that our conception of the solution of this problem is founded entirely on the treatment of local conditions. We have followed carefully and with interest the work of such men as McCollum, Howe, Bunting, Hess, and others, and have endeavored to evaluate the significance of their researches. Let us consider the basis of their hypotheses. Starting with the observation that primitive people in various parts of the world have been found to be relatively immune to caries and periodontoclasia, many investigators have assumed that this immunity was founded entirely on ideal living conditions, comprising correct diet, sufficient sunlight, and ample fresh air. We have already pointed out the fact that these observations of primitive people have overlooked the element of the physical perfection of oral conditions as a factor in dental health. Granting that a diet which contains the proper mineral and vitamin constitutents is essential to mouth health, and granting that sunlight or its equivalent in ultraviolet radiation is also essential, can it be expected that a program based on these measures alone, even if developed to 100 per cent efficiency, will afford adequate protection? Bluntly, we do not believe so. Even primitive people have seldom exhibited so high an immunity to caries and periodontal disease as to make this hypothesis tenable. We do not wish to be understood as

claiming that dietary improvement will fail to bring measurable benefit, but we wish to emphasize the need, in any investigation of these problems, of a fully rounded consideration of all the factors involved.

Even if we were to assume that investigations along dietary lines would result in the establishment of the fact that oral disease could be controlled by this means alone, its application would still present a problem of probably insuperable difficulty. Remember, in application (that is, in practice), we are dealing with facts, not theory. It is difficult to conceive that any considerable number of human beings, especially those living in urban and suburban centers, can be induced to follow a dietary regimen whose outline must presumably be quite rigid. This involves both psychologic and economic difficulties. Living conditions in the larger cities and the human equation will inevitably militate against success along this line.

Much research is being carried on as to the effect which may be produced by the use of cod-liver oil, irradiated substances, or of direct ultraviolet radiation, often in conjunction with calcium medication. The results of research in this field on laboratory animals, and also on children, have been most interesting, and have given rise to hopes that this type of treatment may be of benefit when applied to the human being. Without considering the fact that this type of treatment is essentialy artificial, and may have shortcomings which we do not as yet know, it should be kept in mind that the effect of this treatment is essentially transitory. Hess, in a recent lecture before the First District Dental Society of the State of New York, stated very definitely that protection against rickets, which is afforded by sunlight, ultraviolet radiation, and medication with irradiated substances, is maintained only so long as the treatment is kept up—that, in other words, the protection is not permanent. This is a statement of great significance to those interested in the prevention of oral disease by any such method. We need not elaborate upon it. Another thing we must remember is the fact that a large number of people, living without the benefit of the artificial vitamin D intake, have a high immunity to caries or periodontoclasia, or both.

In considering the problem of research from the various standpoints we have mentioned, it will be obvious that we hold to the idea of a research conducted at least partly along clinical lines, in which full atten-

tion shall be given to the factors that influence nutrition, but in which as great if not greater attention shall be paid to the local factors we have been discussing. In this connection it must be stated that successful study of the effects of traumatic occlusion can be made only by one who is completely familiar from the clinical standpoint with this phenomenon. We are here concerned not only with those traumatic stresses found in cases of gross malpositions and malformations of the teeth, but we must also give equal consideration to those minor occlusal disbalances that can be detected only in the closest observation by trained clinicians. We are impelled to make this statement through numerous experiences with our own shortcomings in the management of cases of periodontal disease. Repeatedly we have been confronted with lesions which refused to heal, only to find after several fruitless attempts that the fault lay in our own failure to discover some relatively insignificant occlusal interference which had escaped detection.

In conclusion, let us revert once more to the thought of the aboriginal native of some dentally favored land, whose perfect teeth have been attributed to dietary perfection and to the influence of sunlight, but who also exhibits in his dental mechanism that degree of natural and harmonious wear which has provided for him a perfectly adjusted innocuous occlusal relationship.

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Scientific Proceedings of the New York Section[1]

March 13, 1930

BISSELL B. PALMER, D.D.S., F.A.C.D., *Editor*

Meeting held at the School of Dental and Oral Surgery, Columbia University, 630 West 168th Street, New York City, March 13, 1930. *Chairman:* Leuman M. Waugh, D.D.S., F.A.C.D., President of the Section.

Scientific program

I. The occurrence of mottled enamel among the Chinese. *Bert G. Anderson*, D.D.S., and *Paul H. Stevenson*, A.M., M.D. 265
II. Diagrammatic recording of periodontal disease. *Isador Hirschfeld*, D.D.S. 266
III. Calcification of teeth and bones on rachitic and non-rachitic diets. *Maxwell Karshan*, M.A., Ph.D. 267
IV. The present status of the investigation of the cause and the geographical distribution of mottled enamel. *Frederick S. McKay*, D.D.S. 268
V. Demonstration of methods for the separation and identification of proteins in enamel. *Theodor Rosebury*, D.D.S. 268
VI. Primary mouth manifestations of skin diseases. *Joseph Schroff*, M.D., D.D.S. 269

Abstracts

I. THE OCCURRENCE OF MOTTLED ENAMEL AMONG THE CHINESE[2]

Bert G. Anderson, D.D.S., and Paul H. Stevenson, A.M., M.D., Department of Oral Surgery and Anatomy, Peiping Union Medical College, Peiping, China

The common occurrence of mottled enamel among the Chinese is reported for the first time. While generally distributed over the whole

[1] The last preceding series of abstracts of proceedings of the New York Section was published in the *Journal of Dental Research*: 1930, x, p. 113.

[2] Published in the last preceding issue: *Journal of Dental Research*, 1930, x, p. 233.

of North China, the significantly higher incidence of the condition in certain regions is shown by a statistical comparison of observations made in two widely separated centers. A gradual decrease in percentage incidence of the condition among individuals in the later age-groups of the population is noted. This observation leads the authors to suggest that the condition in question is most probably a manifestation of constitutional deficiency. The need for correlational studies on the occurrence of mottled enamel, in connection with other morbid conditions affecting individuals in the adolescent period, is emphasized.

II. DIAGRAMMATIC RECORDING OF PERIODONTAL DISEASE

Isador Hirschfeld, D.D.S., Dental School, Columbia University, New York City

Among the various means that may be employed by the periodontologist to record gross clinical abnormal and pathologic conditions of the teeth and periodontium, the outstanding ones are radiography, casts, photography, and diagrammatic record charts. There is no doubt that the ideal method should include them all, as each has its special advantage; but for various reasons, diagrammatic recording is the one most indispensable. It has greater possibilities for embodying more detailed information, and can be accomplished with greater facility than any of the others. Furthermore, it is a more or less itemized record of the complete clinical examination of a case. A well planned and carefully executed diagrammatic record chart may prove valuable to the periodontist not only as an aid in more efficient and more expeditious service, but also as a record for future comparison. Indeed, its potentialities are numerous. It has proven to be a means of much satisfaction to both the operator and his patients.

For this purpose the essayist has, through a process of elimination, evolved a series of about fifty diagrammatic symbols which may be noted rapidly and accurately, and may be read at a glance like a photograph. These were planned with the idea of achieving both simplicity of execution and close resemblence to the various symptoms, so that their code might be memorized with a minimum of effort. They are recorded, preferably with a lead pencil, on the ordinary dental chart procurable at a dental supply house. The entire code

will be embodied in a paper on this subject which, it is expected, will be published in the *Journal of the American Dental Association.*

III. CALCIFICATION OF TEETH AND BONES ON RACHITIC AND NON-RACHITIC DIETS[3]

Maxwell Karshan, M.A., Ph.D., Laboratory of Biological Chemistry, School of Medicine, Columbia University, New York City

Chemical and histological changes in teeth as a result of deficient diets have been reported by a number of investigators. Assuming that a reduction in calcium, phosphorus, and ash of the incisor teeth of rats would be produced by a rachitic diet, it was planned to determine whether the teeth would respond to the same curative agents as do the bones. A modified Steenbock diet, consisting of yellow-corn

TABLE 1

Averages, and average deviations, for calcium and phosphorus on diets in Group I. (The figures represent the percentage in the dry weight of the alcohol-ether extracted material)

DIET	TEETH		BONE	
	Ca	P	Ca	P
	per cent	*per cent*	*per cent*	*per cent*
1. Rachitic	26.7 ± 0.6	13.8 ± 0.5	11.3 ± 1.2	5.9 ± 0.8
2. Rachitic plus KH_2PO_4	26.2 ± 0.8	13.8 ± 0.6	20.3 ± 0.7	9.7 ± 0.4
3. Rachitic plus KH_2PO_4 plus cod-liver oil	26.5 ± 0.5	14.0 ± 0.1	21.8 ± 0.7	10.5 ± 0.5

meal (66 percent), wheat gluten (20 percent), egg albumin (10 percent), calcium carbonate (3 percent), sodium chloride (1 percent), spinach (10 grams per rat per day) and water (ad. lib.), was used. This diet produces marked rickets in rats; the addition of KH_2PO_4 (2 percent) or cod-liver oil (2 percent) prevents or cures the disease.

The calcium, phosphorus, and ash of the incisor teeth and tibias of albino rats were compared on two groups of diets as follows:

Group I. (1) Rachitic, (2) rachitic + KH_2PO_4 (2 percent), (3) rachitic + KH_2PO_4 (2 percent) + cod-liver oil (2 percent).

[3] This work, aided by the Research Grant from the Chemical Foundation to the Department of Biological Chemistry, will be published, in full, in the *Journal of Dental Research.*

Group II. (4) Rachitic + KH_2PO_4 (2 percent), (5) rachitic + KH_2PO_4 (2 percent) + cod-liver oil (2 percent), (6) rachitic supplemented, after 30 to 45 days, by KH_2PO_4 (2 per cent), (7) rachitic supplemented, after 30 to 45 days, by cod-liver oil (2 percent).

In spite of the fact that marked reductions in calcium, phosphorus, and ash were produced in the bones on the rachitic diet, no significant variations from the normal were obtained for the teeth, as is indicated by the data in the accompanying table, which gives the averages and average deviations for calcium and phosphorus on diets in Group I. In Group II, also, no significant variations in the teeth were found.

IV. THE PRESENT STATUS OF THE INVESTIGATION OF THE CAUSE AND THE GEOGRAPHICAL DISTRIBUTION OF MOTTLED ENAMEL[4]

Frederick S. McKay, D.D.S., New York City

The paper was a condensed summary of the present knowledge of the geographical distribution of mottled enamel, and the associated water conditions in so far as they have been observed in the various endemic districts, not only in the United States, but in other parts of the world. There was included, also, a complete bibliography of the subject, showing all articles contributed so far as known since 1902.

V. DEMONSTRATION OF METHODS FOR THE SEPARATION AND IDENTIFICATION OF PROTEINS IN ENAMEL

Theodor Rosebury, D.D.S.,[5] Laboratory of Biological Chemistry, School of Medicine, Columbia University, New York City

A demonstration of the methods and findings published in preceding issues of the *Journal of Dental Research.*[6] Keratin is the only protein present in enamel. Its quantity, in several direct determinations, did not amount to more than an average of 0.42 percent of the enamel dried to constant weight at 105°C. For fresh enamel the value would obviously be somewhat less. The function of the keratin in enamel

[4] To be published in the next issue of the *Journal of Dental Research.*

[5] William J. Gies Fellow in Biological Chemistry at Columbia University. Second appointee, July 1, 1928—January 31, 1930.

[6] Rosebury and Gies: *Journal of Dental Research,* 1929, ix, p. 299; Rosebury, *Ibid.,* 1930, x, p. 187.

appears to be mechanical only. Enamel does not contain soluble proteins, and therefore is not traversed by proteins in lymph or saliva.

VI. PRIMARY MOUTH MANIFESTATIONS OF SKIN DISEASES[7]

Joseph Schroff, M.D., D.D.S., Department of Oral Pathology, School of Dental and Oral Surgery, Columbia University, New York City

It is now well recognized that not only may the mouth be responsible for bodily ailments, but also that bodily ailments may be manifested early in the mouth. As a means of further emphasizing this relationship between medicine and dentistry, several interesting cases of lichen planus, pemphigus, and herpes simplex were cited. These cases of skin disease are of special importance to the dentist in that the initial lesions were observed in the mouth in the absence of skin manifestations. Statistical studies show that, in lichen planus, primary mouth manifestations occur approximately in 26 percent of all cases; while in pemphigus, approximately 50 percent of all cases start with mouth lesions, with or without subsequent skin involvement. The salient physical signs of lichen planus, pemphigus, and herpes simplex were discussed in addition to the differential diagnosis of the mouth signs of these disorders.

[7] Published in the last preceding issue: *Journal of Dental Research*, 1930, x, p. 219.

RESEARCH IN THE USE OF A RATING SCALE AS A MEANS OF EVALUATING THE PERSONALITIES OF SENIOR DENTAL STUDENTS[1]

R. K. BROWN, M.S., D.D.S.

School of Dentistry, University of Michigan, Ann Arbor, Mich.

English Bagby in his recent work, "The psychology of personality," has given us this introduction to this paper:

"Success in almost every line of vocational endeavor depends upon an ability to make a favorable impression on possible clients or customers. It would be probably agreed that in most professions, the economic importance of the factor of personal charm is greater than technical skill and almost on a par with reputation. Personal charm is, in part, a function of appearance and dress, but neither of these is so significant as habits of speech and conduct.

"Although the development of personality can be controlled in a properly organized educational system, it cannot be said that the modern educational agencies are very effective in this connection. Personality development is left largely to the home and to chance experiences, and typical parents are poorly qualified to administer education of this type."

We recognize the fact that there is a difference between the life of a business man following the marts of trade and that of a professional man who renders health service, but we realize also that certain traits are fundamental and common to both walks of life. The studies of personality that have been made in the business world may be used to establish a working hypothesis for a similar study in professional life.

[1] Read at a session of the Seventh Annual Meeting of the American Association of Dental Schools, in a program coördinated with that of the Eighth General Meeting of the International Association for Dental Research, Royal York Hotel, Toronto, Canada, March 24–26, 1930. (See abstract in this issue: *Journal of Dental Research*, 1930, x, p. 372.) To be published also in the *Proceedings of the American Association of Dental Schools.*

F. A. Moss defines personality capably in his book entitled "Applications of psychology." This work should be in the library of every teacher. He states:

"There was a time in the history of our race when our forefathers were pleased to be able to measure in pounds, it was so much more accurate than guessing. Then they were even more pleased to be able to measure in ounces. The measuring of the physical world is now reduced to a science. It is reasonable to expect that human beings will make similar progress in measuring other humans. We are not at the pound stage in measuring many human traits but in the future we will be able to measure to a high degree of accuracy.

"The most important group of traits the psychologist or human engineer has to measure is the group constituting personality. These traits determine an individual's interest in life; his ability to live socially with his fellow human beings; his success in school and his attainments in his chosen profession. The accurate measurement of these traits is invaluable to the teacher as well as to the business manager or employer in industry."

The frequent occurrence of the word "trait" would call for its definition: *A trait is a mode of reaction that tends to differentiate one individual from another. Individuality is the sum total of these measurable differences that makes a man what he is and also shows why he differs from other men. Personality is an individual as perceived by others. It is the individual as he is reflected in the social mirror.* Personality consists of an individual's native traits modified or accentuated by his training and environment. Personality is the result of the traits he possesses at birth plus his experiences through life. Man is born with certain components or traits of his personality fixed at birth. These are *comprehension, judgment, ability to see relationship,* and other traits falling under the general classification of intelligence. The emotional and physical traits also depend on an individual's original make-up at his start in life. Traits of *temperament, ethical ideals,* and *attitudes* of *conventionality* are largely the result of training and environment, and are susceptible to change. The student, during his scholastic life, is in a plastic stage and his personality can be modified with greater ease and facility than is possible after maturity. Traits that are fixed at birth allow of no modification, but traits that are the result of training and environment present the greatest field to the personnel worker.

The measuring of these traits during early adolescence is a virgin field teeming with possibilities.

The measuring of intelligence may be called almost an exact science. Intelligence, according to Thorndike, is of three kinds:

"1. Abstract intelligence—the ability to deal with ideas.
"2. Social intelligence—the ability to deal with people.
"3. Mechanical intelligence—the ability to deal with mechanical contrivances."

An individual may possess all three kinds in the highest or lowest degree, or may be high in one or two, and low in one or two. The measuring of a man's intelligence is important in a study of his personality, and the possession of a high degree of Thorndike's three kinds of intelligence would make for success. The most successful men do not rank highest in abstract intelligence, and do not receive high grades in school. They rank high in social intelligence, for they please the common people. It has been said that abstract intelligence knows what to do, but social intelligence knows how to get it done.

The application of this outline of intelligence, as given by Thorndike, is valuable to the dentist. Our profession calls for individuals possessed of high degrees of social intelligence with the mechanical and abstract types both necessary, but in less degree. The manner and bearing, as well as the personal appearance, of a professional man should be such that any contacts he makes in his professional or social life will be of the most favorable kind. First impressions are the most lasting. The traits comprising the social aspects of a professional man's personality should receive close study, for these traits make the foundation for success in the conduct of his practice. A dental service rendered by a dentist with a pleasing personality seems to accomplish more than one rendered by a dentist whose impression on his patients is more or less negligible.

Our studies have recognized the fact that scholastic grades are a measure of achievement as well as a measure of intelligence, but we have found that the study of each individual student as to how and why he differs from his fellow students may be of inestimable value to the student in his professional life. The teacher has not fulfilled his obligations to his students until he has made a careful study of their

personalities. This must be done by some objective means that will weigh or measure each personality by comparison. The results

Name of Student JOHN SMITH Rater R.K.B.

Chair No. 38 Date 2/15/30

	I	II	III	IV	V
1. APPEARANCE: Consider his appearance and the impression it makes on his patients; his neatness and appropriateness of dress, care of person, absence or possession of physical defects or peculiarities. Comments: BAD BREATH	Objectionable	Open to criticism	Acceptable ✓	Definitely favorable	Highly prepossessing 3
2. MANNER AND BEARING: Consider these as affecting the confidence and respect which others have for him. Comments: EGOTISTICAL	Handicapped	Could be improved ✓	Ordinarily acceptable	Attractive	Unusually impressive 2
3. CLEARNESS OF THOUGHT: Consider this as well as clearness of expression. Are his ideas conveyed clearly and effectively, or does he leave you in doubt as to his meaning? Comments:	Thinking unclear	Sometimes unclear	Varies	Thinks and talks clearly ✓	Highly effective 4
4. JUDGMENT: Consider the soundness and readiness of his judgment; his ability to think through and find good solutions for difficult problems; his resourcefulness and intelligent alertness. Comments: VERY RESOURCEFUL	Slow or erratic	Not alert or accurate	Mediocre	Alert and capable	Keen sound thinker ✓ 5
5. DECISION: Consider the speed, finality, and value of his decisions. Comments:	Indecisive	Cautious	Prompt ✓	Tenacious	Unyielding 3
6. TACT AND COURTESY: Consider these in his meeting and handling others. Does he adapt himself to them or does he intentionally or unintentionally offend? Comments: DOES NOT CONSIDER OTHERS AS HE SHOULD	Tactless ✓	Slight friction	Normally courteous	Congenial	Highly adaptable 1

6)18
3

FIG. 1. First page of the graphic rating-scale, showing method of grading a student on the various traits. The average for the first six traits is 3. The same system is followed in rating the twenty-one traits that were selected.

secured can be used by the student in an effort to modify those of his traits that are too predominant, or too recessive, in order to acquire

the well rounded personality that will enable him to make effective social contacts during his professional life.

From our studies in collaboration with Professors H. F. Adams and Adelbert Ford, of the Psychology Department in our University, we have chosen the rating scale as a means of measuring traits that have seemed essential to the success of a dentist in his professional life (*fig. 1*). Similar scales have been in use in the business world, and, as

Traits comprising the rating scale of the senior dental students of the University of Michigan

(1) Appearance
(2) Manner and bearing
(3) Clearness of thought
(4) Judgment
(5) Decision
(6) Tact and courtesy
(7) Attractiveness
(8) Talkativeness
(9) Cheerfulness
(10) Aggressiveness and initiative
(11) Reasonableness
(12) Tolerance and openmindedness
(13) Detail
(14) Diagnostic ability
(15) Type of work
(16) Conscientiousness
(17) Coöperation
(18) Perseverance
(19) Industry
(20) Desire for improvement
(21) Ideals

Professor H. F. Adams has said, "in fact, in any problem where objective ratings of personal traits are necessary, the rating-scale method has been the most reliable one available. Ratings up to the present time are the most accurate measure of any or all traits of personality!"

The graphic rating scale is the most accurate when a group to be rated has more than thirty or forty individuals in it. The order of

merit type and the Army rating scale will not function as efficiently in the larger groupings. Webb, in his classic monograph, "Character and Intelligence," in the *British Journal of Psychology* for 1915, lists forty-eight traits that are distinctive and are the component units of personality. These traits fall into five groups:

(1) Physical traits which are bodily attributes, and purely objective
(2) Mental traits, the basis of intellect and intelligence
(3) Social traits dealing with man and his contacts with his fellow men
(4) Temperamental traits comprising the emotional side of an individual
(5) Volitional traits that form the character of an individual

From Webb's forty-eight traits we have listed twenty-one that were considered of importance to a well rounded personality. These are listed in the accompanying summary. Dean Ward, Professor Adams, and myself selected these carefully, and formulated them in a graphic rating-scale. The scale and the statistical methods used in the compilation of our results were checked by Professor H. F. Adams of the Psychology Department in our University.

Each trait selected was required to be:

(1) Unique
(2) Distinct, in that it possessed no overlapping with other traits
(3) Different

The rating scale we use must qualify as follows:

(1) It must be valid; it must measure what it is to measure—personality.
(2) It must be objective; different raters, applying the scale to the same person, obtain scores or measures that are practically identical.
(3) It must be reliable; when given two or more times to the same group, the two scores have a high coefficient of correlation. Mathematical formulas are used to establish the objectivity and reliability of any given test.

Our rating scale fulfills these qualifications, if it is borne in mind that any system of measurement has three variables:

(1) The measuring instrument itself
(2) The one who uses the instrument
(3) The subject to be measured

Personality traits are relative, they cannot be measured in terms of any accurate standard such as pounds, or inches. We must measure differences, which are easier to detect than either direction or amount of difference.

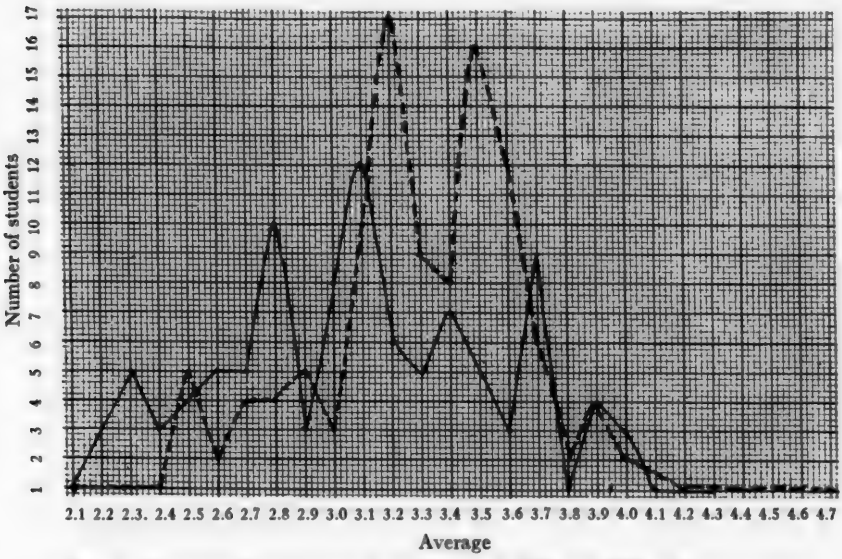


FIG. 2. The personality averages of the classes of 1929 and 1930, plotted as curves. Personality averages ran from 2.1 to 4.7. Each individual, given his personality average, can ascertain his position on this curve.

——— Class of 1929.
- - - - - " " 1930.

Personality averages:

				Ranges	
1929	*1930*	*Grade*	*Percent*	*1929*	*1930*
10	11	A	10	3.9–4.3	3.8–4.7
18	18	B	20	3.5–3.8	3.6–3.7
41	50	C	40	2.9–3.4	3.2–3.5
20	28	D	20	2.6–2.8	2.6–3.1
13	8	E	10	2.1–2.5	2.1–2.5
102	115				

The rating of a class is carried through by two or more raters. The average class-personality is found, and a curve is plotted so that each student, upon receiving his master rating-scale, knows his position on

the personality curve with respect to his fellow classmates (*fig. 2*). A curve is plotted that shows the class-average of each trait, from which the student may ascertain the traits in which he ranks high and those in which he ranks low in comparison to his class as a whole (*fig. 3*). The scale will give him a cross section of his personality as seen by his teachers. If he desires to do so, the student can profit materially

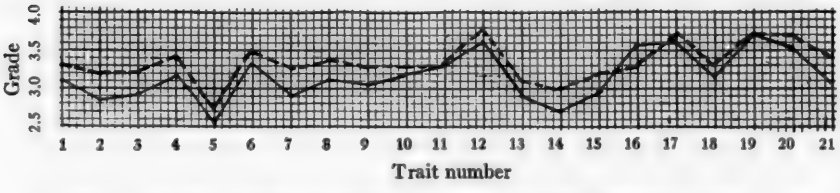


FIG. 3. The class average for each of the twenty-one traits, plotted as a curve. The results for the classes of 1929 and 1930 were used. Each student can compare his grade on each trait with the average grade of his class for that trait. He can ascertain those traits in which he is below, and those above, the rest of his class. This gives him a working basis on which to modify his personality.

——— Class of 1929.
- - - - - " " 1930.

Class average for each trait: 1929 and 1930:

Trait No.	Class '29	'30	Trait No.	Class '29	'30
1	3.1	3.3	12	3.6	3.8
2	2.9	3.2	13	2.9	3.1
3	2.9	3.2	14	2.7	3.0
4	3.1	3.4	15	3.0	3.2
5	2.6	2.7	16	3.5	3.3
6	3.3	3.5	17	3.6	3.7
7	2.9	3.3	18	3.2	3.3
8	3.1	3.4	19	3.7	3.7
9	3.1	3.3	20	3.6	3.7
10	3.2	3.3	21	3.2	3.4
11	3.3	3.3			

from this knowledge by modifying his personal traits so as to bring him nearer the ultimate personality desired and sought by all of us.

The teacher has one more instrument that will measure the abilities of his students. Character and personality are of equal importance with ability in the achievement of knowledge and skill. The estimation of these will give us a firmer ground upon which to stand in making the decision as to whether a man possesses the qualifications to become a graduate.

I have found that the scale has another distinct value. As director of the operative department of our School, it is important for me to evaluate the ability of the different teachers on my staff to observe and to judge. By comparing the ratings of the different staff members who have rated the students, I secure a valuable insight into the ability of each teacher to evaluate the individual student, and I am able also to place relative values on the judgments and observations of these teachers as they pertain to many problems that arise during the scholastic year in the conduct of the operative clinic.

We hope, in the future, to be able to give correlations between scholastic and clinical grades, personality ratings, and postgraduate success in practice. These results can be secured only after a certain lapse of time, but may prove very interesting and valuable. A fair amount of practical information as to a graduate's success in practice can be ascertained by the use of a "hidden" questionnaire, mailed to graduates after two, five, or ten years of practice, depending on the information desired. The evaluation of personality should begin in the first year of the dental curriculum, so that the student can have sufficient time to develop his personality under competent guidance, for we are aware that such changes are made with greater facility in youth than in later life.

In conclusion allow me to present a classical definition of personality. It is from the pen of that great scholar and educator, President C. W. Eliot of Harvard:

"Every one now believes that there is in man an animating, ruling, characteristic essence or spirit, which is himself. This spirit, dull or bright, petty or grand, pure or foul—looks out of the eyes, sounds in the voice, and appears in the manners of each individual. It is what we call personality."

BIBLIOGRAPHY

"Ways of the Mind," H. F. Adams: Scribners.
"Psychology of Personality," English Bagby: Henry Holt.
"Training and Selection of Men," Donald A. Laird: McGraw-Hill.
"Exploring Your Mind," A. E. Wiggam: Bobbs Merrill.
"Applications of Psychology," Fred A. Moss: Houghton-Mifflin.
"Teaching of Ideals," W. W. Charters: MacMillan.

STUDIES ON INORGANIC SALT METABOLISM

V. The Effect of Faulty Diet on the Dentition of Brood Bitches, and the Dental and Skeletal Development of Their Offspring[1]

MARTHA R. JONES, Ph.D.[2]

Department of Pediatrics, University of California Medical School, San Francisco, California

CONTENTS

I. Introduction 281
II. Experimental procedure and results 282
A. Diets 282
B. Cages 283
C. Group I: general data 283
D. Bitch 5: Puppies 22 and 38 284
E. Bitch 7: Puppy 23 287
F. Group II: general data 289
G. Bitch 28: Puppies 42 and 43 289
H. Bitch 31: Puppy 49 290
III. Discussion 293
IV. Summary 303
V. References to literature 305

I. INTRODUCTION

A review of the literature has revealed surprisingly few studies on the new-born, and none in which dental and skeletal findings in mother and offspring have been correlated with each other and with the maternal diet.

In a long series of detailed experiments, it was observed that brood bitches living in an environment that afforded a negligible amount of ultraviolet radiation, and fed a diet low in calcium, vitamins, and protein, and potentially basic in reaction (bread, meat, and potato),

[1] Presented at a session of the Sixth General Meeting of the International Association for Dental Research, Hotel Mayflower, Washington, D. C., March 25–28, 1928. See abstract: *Journal of Dental Research*, 1928, viii, p. 422.

[2] Aided by grants from the W. H. Crocker fund for research in pediatrics, and from the California Stomatological Research Group.

gave birth to young which showed marked differences in body weight, general well-being, body ash, and mineral content and structure of the bones. Surviving members of successive litters of puppies born to bitches fed continuously on this type of diet showed an increasing proneness to skeletal disorders. Ultimately, 100 per cent of the survivors of four different litters (twenty-two puppies) born to four different mothers developed clinical rickets before they had been weaned.

In this paper, the dental findings on certain mothers and their offspring will be described and correlated with the maternal diet. Puppies in Group I were, with one exception, representatives of the last litters of Bitches 5 and 7. The father of both litters was Dog 1. All three of the dogs were large mongrels, collie predominating, and had lived in the kennels and been fed a stock diet consisting essentially of bread, meat, and potato for more than eighteen months prior to mating. Before and during the last pregnancies, the bitches were fed quantitatively. The diet was similar in composition to the stock diet previously used, but was prepared in such a manner that it was impossible for the animal to exercise choice in the selection of food.

Puppies in Group II were offspring of mothers whose histories were either unknown, or had been in the laboratory kennels and fed a stock diet of bread and meat for varying lengths of time.

II. EXPERIMENTAL PROCEDURE AND RESULTS

A. Diets

Diet 1 consisted of the following combination:

Patent wheat-flour bread (10 per cent moisture)	225.0	grams
Lean ground beef	75.0	"
White potato	600.0	"
NaCl	5.0	"
Distilled water	1200.00	cc.

The bread was dried and ground to a fine crumb. The lean beef was finely ground, and the potatoes peeled and boiled. The meat was placed in about 500 cc. of distilled water, the mixture brought to a boil, and the potato, which had already been cooked, was added and

mashed while the mixture was hot. The bread was then added and the whole thoroughly mixed into a uniform mash, which was thinned to the consistency of a thick gruel with the remainder of the water. The composition of the diet was estimated to be as follows: total calories, 1560; protein, 59 grams; calcium, 0.15 gram; phosphorus, 0.72 gram; potassium, 3.0 grams. The excess of base was equivalent to approximately 13 cc. of normal solution.

Diet 2 consisted of bread and meat exclusively. Scrap meat, usually beef ribs, was purchased from a butcher. It was boiled with salt, and when cold was stripped from the bone and cut into small pieces. Wheat-flour bakery bread was used. It was cut into uniform slices on a machine and air dried. When fed to the dogs, it was softened in hot water and beef stock. The bread and meat were roughly measured—about 225 grams of each were fed daily. While it is impossible to state the exact composition of a diet prepared in this manner, it can be approximated with a fair degree of accuracy. It is certain that the diet contained more protein and fat and less carbohydrate than Diet 1. The calcium content was estimated to be 0.09 gram; phosphorus, 0.69 gram; and potassium, 1.0 gram. The excess of acid was equivalent to approximately 46 cc. of normal solution.

B. Cages

The dogs occupied adjoining cages in a well lighted and ventilated room. Each animal was fed separately in his own cage. During a part of the day they were allowed the freedom of an outside enclosure paved with concrete. The run was built on the north side of a hill and received little direct sunshine. The heavy fog which envelops the district during a large part of the year, and especially during the summer months, greatly reduces skyshine, so that it is believed that the amount of ultraviolet radiation received at any time was negligible. Brief histories and findings on six bitches and thirty-eight new-born puppies, representatives of seven litters, will be given.

C. Group I: general data

The bread, meat, and potato diet described above (Diet 1) was fed quantitatively to four bitches, Nos. 5, 7, 8 and 9, all of which had previously given birth to litters. Bitches 8 and 9 were given sodium

carbonate in addition, in order to determine the effect of excessive amounts of alkali. All of the animals appeared to be in excellent physical condition. Their weights ranged form 20 to 26 kilos. Bitches 5 and 7 were successfully mated, 8 and 9 were not. After the latter two animals had been on the alkaline diet for one hundred and thirty days, dental tissue was excised for histologic study, and the soda was discontinued. Subsequently, an equivalent amount of rice was substituted for the potato. Within thirty days after this change in diet, both animals died in convulsions. The biopsy tissue (upper second and third incisors with investing tissue) showed marked retrograde changes in the alveolar process and resorption of the roots of the teeth. The findings were quite comparable for the two animals. The corresponding tissue excised post-mortem indicated a reversal of the calcifying mechanism. Marked reconstructive changes were evident. Old dead bone was overlaid by new. Marrow spaces which had previously coalesced were separated again by bone growths between them. Along the crests of the alveolar process, and in excavated regions in the dentin of the roots, new bone formation was taking place (*fig. 1*). Histories of Bitches 5 and 7 are given below.

D. Bitch 5

Bitch 5 was received at the kennels when she was about two years of age with a litter of nine vigorous puppies three weeks old. A superficial dental examination was made on the mother. Her mouth was found to be extraordinarily clean, and her teeth white and apparently sound. After the second pregnancy, which occurred eight months later, both upper and lower incisors were found to be badly worn, the latter almost to the gingivae. The diet during this time consisted almost entirely of scrap beef. Subsequently, her diet was changed to bread, meat, and potato in approximately the amounts given above. During the next eighteen months two more litters were born. Representatives of both litters were killed at birth, and certain observations made on the bodies and bones. The findings were correlated with the subsequent behavior of their surviving litter-mates. The mineral content of the bodies and bones of the puppies killed at birth was found to be low, and the bone structure abnormal. The surviving members of the litters showed an increasing susceptibility to skeletal

disorders, all of those in the last litter developing clinical rickets before weaning.

The dietary regimen was continued, but four and one-half months prior to the next mating, quantitative feeding was instituted, and certain metabolic and blood studies made before and during pregnancy. Detailed dental examinations were also made at intervals. The metabolic process, which earlier resulted in disintegration of the tooth substance, had already become static and remained so during this period. There was some gingivitis. Her mouth was less clean than formerly, but no striking abnormalities were observed. During pregnancy, the bitch was occasionally seen in convulsions. She had not been known to have them before. They were not severe, and she apparently suffered no serious ill effects. Her appetite was good, and she consumed practically all of the food offered during the entire gestation period. At the time of parturition she had a convulsion and died before the birth of her young. On postmortem examination her dental condition was found to be essentially the same as that previously observed. Of the tissue prepared for microscopic study, the upper right first, second, and third incisors revealed a most extraordinary condition of the alveolar bone. Scattered throughout the compact bone, but more on the margins of the septal process, were regions that appeared as though the inorganic constituents had been leached out. Fibers and bone corpuscles in various stages of degeneration stood out in bold relief (*fig. 2*). Numerous small lacunae, some containing giant cells, bordered the margins of the septal process, but the peridental membrane was narrow. The pulp of the teeth was fibrous, and the layer of odontoblasts entirely absent in regions.

Dental findings on new-born Puppies, 22 and 38, representatives of the last two litters born to Bitch 5 and Dog 1, are described below.

Puppy No. 22 was the smallest of a litter of ten; weight of the litter, 2550 grams. The weights of the individuals varied from 160 to 330 grams. Five of the ten puppies were sacrificed immediately after birth. The bones of three were prepared for ash analyses and histologic sections, and the whole bodies of the other two for ash determinations. The mineral content of the bones was found to vary from 8.7 to 13.2 per cent. The body ash in the largest and in one of the smallest of the litter was found to be 1.87 and 1.9 per cent, respectively.

The bone structure was abnormal. A photomicrograph of a lower canine of this puppy is shown in *fig. 10*. The section appears to be exactly median. The most striking abnormality is the large mass in the pulp. It stains and looks like dentin. Following this through serial sections, it appears first as a small island in the interior of the pulp chamber, and gradually increases in size until it becomes attached to the inner wall of the dentin layer. It appears to have been laid down irregularly and is surrounded by cells. In the section shown, a large clump of cells is found in the interior of the mass. The space on the margin of the tooth, which appears as a white spot, was an irregular deposit of the same substance lost in sectioning. The odontoblasts are clumped together leaving large intercellular spaces, and the dentin layer is much thinner than that in the teeth of the control puppies. The dental papilla is also less vascular. Compare *figs. 10* and *13*.

Puppy 38 was the smallest of a litter of ten full-term but unborn offspring of Bitch 5 and Dog 1. Three litters had previously been born to these parents. For four and one-half months prior to the last mating both had been fed quantitatively on Diet 1 (bread, meat, and potato), and appeared to be in excellent physical condition. Quantitative feeding was continued during pregnancy. On the completion of the gestation period, the bitch had convulsions and died before parturition. The total weight of the foetuses was 1690 grams, which was markedly less than the birth-weight of the preceding litter. The mineral content of the body substance of the unborn puppies was found to be extraordinarily low—an average of 1.73 per cent, compared with 1.9 and 2.35 per cent in the representatives of the third and second litters, respectively. The total calcium content of the last litter was estimated to be 5.9 grams. The histologic findings in the bones of these puppies were in complete agreement with the chemical. A photomicrograph of a costochondral junction of a rib of Puppy 38 is shown in *fig. 7*. There was marked retardation in calcification. The proliferating-cartilage zone is extraordinarily wide, and the trabeculae thin and poorly calcified. A photomicrograph of a cusp of a lower premolar of this puppy is shown in *fig. 8*; in *fig. 9*, a high magnification of the coronal region of pulp and dentin in a lower canine. Here again, the most striking structural abnormality appears

to be in the odontoblasts and dentin formation. In spite of the fact that the section shown in *fig. 8* may have been cut obliquely, the dentin layer is relatively thin; and the odontoblasts, which are cut transversely, appear to be widely separated. In *fig. 9* the predentin layer is poorly defined, and is separated from the layer of odontoblasts by a space that is traversed by a network of processes from the odontoblasts. The scarcity of blood vessels in this region is conspicuous. Compare *fig. 9* with *fig. 18*, which is a photomicrograph of comparable tissue from Puppy 49 in Group II.

E. Bitch 7

Bitch 7 was a large, robust, mongrel collie. Her weight averaged about 23 kilos. She had been in the kennels for more than two years, and during that time had given birth to three litters of puppies. The father of all her offspring was Dog 1. The two dogs were received at the kennels at about the same time, and had lived under identical conditions of diet and hygiene. Successive litters born to these parents showed an increasing proneness to skeletal disorders, and all of the survivors of the last litter developed clinical rickets before they were weaned. Representatives of the last two litters were killed at birth, and certain observations were made on the new-born puppies. The mineral content of the bodies and bones was low, and the bone structure abnormal.

Prior to the next mating, quantitative feeding was instituted, and a detailed dental examination made. Before and during pregnancy certain observations were also made on blood and urine. Dental examination revealed pyorrhea-like lesions. There was gingivitis, recession of the gum with detachment, and heavy deposits of tartar. The mouth was dirty, but the teeth were sound. Tissue was excised for microscopic study. The tartar at the gingival margins was very hard and flint-like, and was stained black. Histologic examination of the excised tissue showed osteoporotic changes in the alveolar bone, with evidence of an inflammatory reaction. During pregnancy, and on the completion of the gestation period, the bitch had convulsions. Immediately after the birth of her young, she went into coma, and the following day was chloroformed.

There were nine puppies in the litter, the total birth-weight being

1725 grams. The weights of the two preceding litters were 2850 and 2440 grams. The weights of the individuals of the last litter varied from 99 to 240 grams. The percentages of bone ash in the three puppies varied from 7.8 to 10.4 per cent. The ash content of the bodies of six averaged 2.09 per cent. As was found in successive litters born to Bitch 5 and Dog 1, there was a progressive decrease in the mineral content of the offspring of Bitch 7, if it may be assumed that values found in certain individuals were representative of the litter as a whole. The total calcium content of the litter was estimated to be 7.9 grams, and the amount of this element in the body substance of the two preceding litters, 15.4 and 12.7 grams.

Post-mortem dental examination of Bitch 7 showed remarkable healing of the region from which dental tissue had been excised. All of the oral conditions previously observed were slightly exaggerated, but in general there were no marked changes. Histologic examination of the site of the canine, in which there remained a considerable portion of the root, revealed an astonishing amount of inflammation and resorption of cementum, dentin, and alveolar bone. The histologic picture in other regions showed profound resorption of bone and tooth substance, but less evidence of an inflammatory reaction. In certain regions in the alveolar bone, but more marked in the cementum, the histologic picture was strikingly like that observed in Bitch 5. Here again it appeared that the inorganic constituents had been leached out leaving the corpuscles in various stages of degeneration in a matrix of fibers. In the cementum, both on the margins and in the interior, there were numerous light regions that stained like osteoid. In them were many faintly-visible round-bodies or spaces, the structure of which could not be determined. In the interior, bordering the band of "osteoid," were several rows of mononuclear cells. The pulp of the teeth was fibrous. The layer of odontoblasts was entirely missing in regions, and normal pulp elements could not be recognized. *Fig. 3* is a photomicrograph (high magnification) of a region of pulp and dentin in an upper third incisor.

Puppy 23, largest representative of the last litter born to Bitch 7 and Dog 1, weighed 240 grams; average weight of litter (nine), 191 grams. The percentage of ash in his bones (10.4 per cent) was found to be the highest for the three puppies examined. The structure of

the ribs was abnormal—he had suffered an intrauterine fracture, which had partially been repaired with fibrous tissue. A photomicrograph of a cusp of a lower premolar of this puppy is shown in *fig. 11*, and a high magnification of a lateral region of this tooth in *fig. 12*. The same general findings described above are characteristic of this litter also. The dental papilla is less vascular than that in the control group of puppies, the odontoblasts are clumped together irregularly, and the layer of dentin is relatively thin. Under high magnification, the zone separating the odontoblasts from the predentin layer is clearly visible. The ameloblasts are also separated from the enamel layer by a network of cells and fibrils, in which enamel globules are irregularly scattered. Compare *fig. 12* with *fig. 15*, which shows comparable tissue, under the same magnification, from Puppy 43 in the control group.

F. Group II: general data

Dental and skeletal tissues from fourteen puppies in the control group were examined. They were representatives of four litters from four different mothers. The histories of two of the mothers were unknown. They were "street" dogs, and gave birth to litters soon after their arrival at the kennels. The third bitch, No. 28, arrived at the kennels during the third week of pregnancy, and the fourth, No. 31, had been in the kennels for a year before the birth of her last litter. The histories of the latter two animals will be given in detail.

G. Bitch 28

Bitch 28 was a large mongrel terrior. She weighed 18 kilos, and her age was estimated to be about three years. Her mouth was clean; her teeth were white and sound. When she arrived at the kennels she was in the third week of pregnancy. During the remainder of the gestation period her diet consisted of bread and meat. A litter of eight vigorous puppies was born. The total birth-weight was 1716 grams, the weights of the individuals ranging from 157 to 323 grams. Four of the litter were killed.

Roentgenograms of the new-born puppies showed differences in the density of the bones, which were exactly parallel with the percentages of bone ash. The latter varied from 9.7 to 14.7 per cent. The puppies left with the mother grew rapidly. At 21 days of age, roent-

genograms showed differences in skeletal development, which, at 40 days, could no longer be detected. Subsequently, however, when two of the puppies were placed on the basal diet of bread, milk, meat, butter fat, and orange juice, the earlier differences rapidly became apparent. A third puppy of this litter was kept in the open and fed on a mixed diet. Even though ossification appeared to be least advanced in him at the age of 21 days, his development, as far as could be determined by clinical examination and roentgenograms, was normal. The behavior of the surviving individuals of this litter was altogether comparable to that observed in the offspring of the average "street" dog.

The chemical and histologic findings on two of the new-born of this litter have arbitrarily been chosen as standard, and are described below.

Puppies 42 and 43. The birth-weights of these puppies were 190 and 203 grams respectively, both of which were less than the average (215 grams) for the litter. The mineral contents of their bones were 14.2 and 14.7 per cent. Histologic findings on bone and dental tissues were in close agreement. A photomicrograph of a section of rib of *Puppy 42* is shown in *fig. 13.* The junction line is fairly straight, and the proliferating-cartilage zone relatively narrow. The provisional zone of calcification is well defined, and the arrangement of cells and trabeculae orderly. The marrow is cellular on the whole, but there is also a considerable amount of fibrous tissue in regions. Mononuclear cells are much less numerous than in some of the ribs of puppies in Group I, and polynuclear cells are relatively few in number. A photomicrograph of the coronal portion of a lower canine is shown in *fig. 14.* The closely packed, orderly arranged odontoblasts, and the relatively thick layer of dentin, are in striking contrast to those observed in the puppies in Group I. Compare *figs. 11* and *14.* As in the other group, there appears to have been a disturbance in the ameloblasts. In *fig. 15* is shown a high magnification of the lateral region of a lower canine of *Puppy 43.* Compare *fig. 15* with *fig. 12,* which shows comparable tissue from Puppy 23 in Group I.

H. Bitch 31

Bitch 31 was a mongrel—police-collie. She weighed 25 kilos, had been reared as a pet on a near-by ranch, and was about four years old.

Her diet had consisted of table scraps, with very little meat but an abundance of skimmed milk. She had lived in the open all her life, and was received at the kennels with a litter of six puppies five weeks old. The mother and puppies appeared to be in excellent condition. The puppies were weaned, the mother was put on a diet of bread and meat, and all were given the ordinary care. A dental examination revealed a most extraordinary oral condition. Her mouth was dirty. The two upper canines were missing. There was gingivitis, tartar, and recession of the gums. The upper left second and third incisors, with investing tissue, were excised for histologic study. The process of resorption was active. The peridental membrane was wide, and the margins of the septum fringed with lacunae, which contained numerous multinuclear cells. The structure of the pulp tissue was not clearly defined, and the odontoblasts were arranged in festoons.

During the following year, the bitch was kept on the diet of bread and meat described above. In July, 1927, she gave birth to a litter of six puppies whose birth-weight was only 1250 grams. The mother had gained in weight and appeared to be in excellent condition. The entire litter of puppies and the mother were sacrificed. Postmortem examination showed that a profound change had taken place in the dentition of the mother. Many of the teeth were almost denuded of enamel, and even the dentin had suffered disintegration in regions. There were heavy deposits of tartar on the buccal surfaces of the molars. The histologic pictures of the post-mortem material were in striking contrast to that observed in the tissue excised twelve months previously. There was less lacunar resorption, and the peridental membrane was narrower than in the biopsy tissue. The pulp was less fibrous, but the structure of the alveolar bone presented the leached-out appearance observed in the post-mortem tissues of Bitches 5 and 7 (*figs. 5* and *6*). The localization of dental lesions in animals as well as man, and the large part played by chance in the selection of tissue for examination, make the interpretation of such findings as these extremely difficult. The disintegration of the crowns of the teeth of this animal—a phenomenon that has repeatedly occurred concomitantly with accelerated calcification in young puppies—indicates that the differences observed in the histologic pictures of

the biopsy and post-mortem tissues were associated with metabolic changes, rather than the result of a chance selection of material for examination.

The physical condition of the offspring of Bitch 31 was so very poor that it was thought the dental and skeletal findings would be correspondingly abnormal. The reverse, however, proved to be the case. The percentage of ash in the bones was found to average the highest yet observed, the values ranging from 11.1 to 16.1 per cent, with an average of 14.06. The bone ash of ten puppies in Group I averaged 10.0 per cent, and of the offspring of Bitch 28, 12.8 per cent. There was considerable individual variation in bone structure. The outstanding characteristic of the histologic pictures was the large number of osteoclasts. In other respects, the findings were comparable to those observed in the offspring of Bitch 28, and in the new-born of other mothers whose histories were unknown.

The histologic findings in the dental tissues of these puppies were comparable to each other and to those observed in Puppies 42 and 43. Puppy 49 will serve to illustrate.

Puppy 49. The birth-weight of Puppy 49 was 125 grams, the smallest of a litter of six whose average weight was 208 grams. He was born July 5, 1927. The mineral content of his bones was 16.1 per cent, the highest value for any of the puppies examined. The histologic picture of his ribs was dominated by multinuclear cells. Mononuclear cells were also numerous. The junction line was straight and the proliferating-cartilage zone narrow, and the cells were orderly in arrangement. Compare *figs. 16* and *7*, which are photomicrographs of costochondral junctions of the ribs of puppies 49 and 38. A photomicrograph of a section of a cusp of a lower premolar of Puppy 49 is shown in *fig. 17*. The dental papilla is vascular, odontoblasts are closely packed and orderly in arrangement, and the layer of dentin is relatively thick. The ameloblasts are also separated from the enamel matrix. Compare *figs. 17* and *8*. Both of these sections appear to have been cut obliquely. The latter was taken at a slightly lower magnification, which would, of course, minimize the difference in thickness of the dentin layers. *Fig. 18* is a high magnification of the coronal region of pulp and dentin in the tooth shown in *fig. 17*. The predentin layer is clearly defined, the odontoblasts are closely packed

and orderly in arrangement, and the entire pulp is studded in blood vessels. Compare *fig. 18* with *fig. 9*, which is a high magnification of the coronal region of pulp and dentin in a lower canine of Puppy 38 in Group II.

III. DISCUSSION

A comparison of the findings for Bitches 5 and 7 reveals interesting differences. Both were large mongrel collies of about the same size and age. They lived under identical conditions of diet and hygiene, were mated with the same male, and bore four litters of young, the total number of offspring being forty and thirty-nine respectively, during a period of two and one-half years. Their pregnancies, with the exception of the last, occurred at about the same times. Before and during the first gestation periods their diet consisted almost entirely of meat. It was usually scrap beef, and was cooked and fed with the bone. During this time Bitch 5 suffered marked disintegration of the tooth substance, both upper and lower incisors having been worn down almost to the gingivae. The exposed surfaces of the teeth of Bitch 7 remained intact. Subsequently, the diet was changed to bread, meat, and potato. During a period of eighteen months, Bitch 7 developed gross pyorrhea-like lesions, and Bitch 5 had only a slight gingivitis. There were no obvious changes in the enamel of the teeth of Bitch 7, and no further destruction of tooth substance in Bitch 5. Successive litters born to these mothers showed an increasing proneness to skeletal disorders, and representatives of these litters killed at birth had faulty bone structure, and a low percentage of ash in their bodies. Prior to the last mating, quantitative feeding was instituted. Both bitches had convulsions during pregnancy. Bitch 5 died at the time of parturition, and Bitch 7 was chloroformed when at the point of death a few hours after the birth of her young.

Differences in the metabolism of the two mothers is clearly shown in the mineral content of their offspring. During the last pregnancies, the two bitches received exactly the same diet, both in kind and amount. Their appetites were good, and both ate practically all of the food offered. The total birth-weights of the two litters differed by only 35 grams, but the offspring of Bitch 7 had 34 per cent more calcium in their bodies than those of Bitch 5. Representatives of

successive litters born to both mothers showed a progressive decrease in mineral content, the offspring of Bitch 7 invariably having a higher average value than those of Bitch 5. Blood findings in the bitches, before and during pregnancy, were altogether comparable and well within the normal range.

Histologic examination of the dental tissues of the bitches showed marked degenerative changes. The peridental membrane was wider, and there was more resorption of the alveolar bone and roots of the teeth in Bitch 7 than in Bitch 5. In the former animal, all of the regions examined showed more or less evidence of an inflammatory reaction. This was not observed in Bitch 5, in which the histologic picture was dominated by regions in the alveolar bone that appeared to be undergoing disintegration by a process of solution of the inorganic constituents. In the interior of such regions haversion systems remained apparently intact. The same process was active in the tissues of Bitch 7, but the cementum was more involved than the alveolar bone. The pulps of the teeth of both animals were fibrous. In some regions the layer of odontoblasts had been entirely obliterated by fibrous tissue, and normal pulp cells could not be recognized (*fig. 3*). Histologic findings in the offspring of both mothers showed retarded calcification and faulty bone structure. There was considerable variation in the individuals of the same litter, both in respect to structure and composition of the bones. Dental findings showed less variation, and were comparable in the two litters.

Biopsy dental tissues from the two bitches fed Diet 1, supplemented with gradually increasing amounts of sodium carbonate (0.75–4.0 grams) for a period of one hundred and thirty days, were altogether comparable, and showed profound degenerative changes in the alveolar bone and roots of the teeth. These findings, with the subsequent history of the bitches, have already been described (1).

The substitution of bread and meat for a mixed diet, which consisted essentially of potato and vegetables with raw skimmed milk ad libitum, apparently exerted a profound influence upon the dentition of Bitch 31. In spite of the fact that she lived under most favorable hygienic conditions, and her diet had been rich in minerals and vitamins, pyorrhea-like lesions developed to a marked degree. Both upper canines were missing. Roentgenograms of the sites of the missing

teeth revealed small bodies near the surface of the gum that looked like fragments of roots. The overlying tissue was smooth and showed no evidence of trauma. The owners of the bitch did not know of any injury she had received, nor that the canines were gone. It is almost inconceivable that the roots of canine teeth in an adult dog could be resorbed to such an extent that the teeth would be entirely lost. Yet, the profound degenerative changes observed in the biopsy tissue from this animal indicate that such was the case. Root resorption is a common occurrence in animals on diets that may be well proportioned in respect to calcium and phosphorus, but which contain a certain preponderance of basic ions, and has been so extensive in some of the puppies that permanent teeth have been spontaneously shed. The biopsy tissue from Bitch 31 presented a histologic picture that was altogether comparable to that of Bitches 8 and 9, which received Diet 1 supplemented with sodium carbonate, and closely resembled the diffuse atrophy in human tissues described by Gottlieb (2). Interestingly enough, the owners of Bitch 31 had pyorrhea. Concomitant with a change in diet and hygiene, the "pyorrhetic" process appears to have been arrested, and during the following year, the crowns of the teeth suffered rapid and profound disintegration. Unfortunately, a dental examination was not made on this animal at the beginning of pregnancy, and it cannot be said with certainty, but it is believed, that the destruction of the tooth substance occurred during this period. A similar condition has been observed in the teeth of a large number of puppies on experimental diets, and has been associated with accelerated calcification (3).

A comparison of post-mortem dental findings for Bitches 5, 7, and 31 shows interesting similarities as well as differences. The extraordinary appearance of the alveolar bone—corpuscles in various stages of degeneration in a matrix of fibers—was a striking feature of the histologic pictures of tissues from all three animals. This suggests that the condition may be associated with pregnancy. The fact that it was not observed in the biopsy tissue from Bitch 31, and in neither the biopsy nor post-mortem tissues from Bitches 8 and 9, strengthened this view. It was observed, however, in biopsy tissue from a bitch whose history was unknown. Subsequently she was fed a diet of bread and meat, but the experiment was prematurely terminated, and the effect of the diet on the alveolar bone was not determined.

Differences in the chemical findings for the two groups of puppies are striking. The mineral content of the bones of representatives of the litter born to Bitch 7 averaged 9.4 per cent, and of that of the offspring of Bitch 31, 14.0 per cent. There were nine puppies in the former litter, and their average weight was 191 grams; there were only six in the latter, with an average weight of 208 grams. It could be argued that the size of the litter determines the absolute amount of minerals in the individual. That this is not necessarily true is shown by the fact that there were ten puppies, in the second litter born to Bitch 7 and Dog 1, whose average weight was 285 grams. The calcium content of the fresh body-substance was 0.54 per cent. The fourth litter born to these parents contained nine puppies, with an average weight of 191 grams and a calcium content of 0.46 per cent. Then again, the calcium content of two successive litters born to Bitch 5 and Dog 1, each litter containing ten puppies, was 10.45 and 5.9 grams, respectively, these values being calculated from percentages in representatives of the litters. Thus it seems that certain combinations of dietary and hygienic factors exert markedly different influences upon calcification in the dog.

A comparison of the dental findings in the two groups of puppies shows interesting differences. The most striking characteristics of the histologic pictures for the puppies in Group I are the degenerate condition of the odontoblasts, the relative thinness of the dentin layer, and the small blood-supply of the pulp. Compare *figs. 8* and *17*, *9* and *18*, *11* and *14*, *12* and *15*, which are photomicrographs of dental tissues of puppies in Groups I and II, respectively. Examination of *fig. 9*, which is a high magnification of the coronal region of pulp and dentin in a canine of Puppy 38, shows an almost total absence of blood vessels bordering the predentin layer. The odontoblasts are scattered and irregularly arranged. These findings are in striking contrast to the histologic pictures of pulps in the teeth of the puppies in Group II (*fig. 18*). In keeping with the apparent disturbance in the odontoblasts, the dentin appears to be thinner in the teeth of the puppies in Group I than in those in Group II. This, however, is difficult to determine on account of differences in the angles at which the sections were cut. Since the teeth are unerupted and are irregularly set in the jaws, it is impossible to secure sections of the various

regions that are altogether comparable. Regardless of angle, however, the odontoblasts in the teeth of the puppies in Group I are widely separated, compared with those in Group II, and appear as fibers clumped together in bunches, with large intercellular spaces.

A comparison of *figs 9* and *18* shows also a striking difference in the formation of predentin. In *fig. 9* the marginal lines are indistinct, there being no definite line of demarcation between the calcified and non-calcified areas. In other sections, the predentin layer is better defined (*fig. 12*), but even in these the odontoblasts are separated from the organic matrix by a space irregularly traversed by fibrils entering the matrix. Here again, technical differences, thickness and angles of sections, make interpretation difficult. The findings are so consistent, however, regardless of technique, that the conclusion that the differences are real is inevitable.

An interesting finding, which occurred frequently in the puppies of both groups, is the disturbance in the ameloblasts (*figs. 11, 12, 14* and *17*). The ameloblasts were separated from the enamel matrix by a network of fibers in which enamel globules were scattered. Obviously, if the failure in function of the enamel and dentin-forming cells was dietary in origin, the mechanisms were controlled by different factors. The fault that resulted in the failure of the ameloblasts was common to both diets, while that affecting the odontoblasts was present only in Diet 1. Wolbach and Howe (4) reported that vitamin-A deficiency in the diet of rats exerted a profound influence upon epithelial tissues. Microscopic changes, usually of minor degree, were also regularly found in the odontoblasts and in the pulp. Atrophy of the dentin-forming cells from slight shrinkage to complete disappearance was noted; also osteoid tissue, which was incorporating as well as surrounded by osteoblasts. Such findings were not observed in the offspring of Bitch 31, which was fed a diet of bread and meat exclusively for several months both before and during pregnancy. M. Mellanby (5) has shown that diets deficient in fat-soluble vitamins and high in cereals have a marked effect upon the form and structure of puppies' teeth. Since both diets used in the experiments reported above were low in vitamins, the disturbance in the ameloblasts that occurred in the offspring of all the bitches could easily be explained on the ground of fat-soluble-vitamin deficiency. This, however, does

not offer a satisfactory explanation of the observed differences in dentin formation and pulp structure in the two groups of puppies.

Numerous investigators have studied the effect of the antiscorbutic vitamin on dental tissues. Histological changes in the teeth resulting from vitamin-C deficiency have been shown to occur primarily in dentin and pulp. In extreme cases, in guinea pigs, the normal orthodentin is largely substituted by osteodentin. The pulp tissue is so degenerated that the normal elements can scarcely be recognized. The process begins with hemorrhages in the upper part of the pulp and extends toward the apex. Such a condition has not been observed in any of the puppies' teeth. Furthermore, potato is relatively rich in antiscorbutic vitamin. Since the disturbance in the odontoblasts occurred in puppies whose mothers were fed the potato diet, the fault, if of dietary origin, could not have been due to vitamin-C deficiency. Findings reported in the literature, on the teeth of various laboratory animals suffering from vitamin deficiencies, do not closely agree with the observations on either the adult dogs or new-born puppies in these experiments, and it appears that some other factor or combination of factors regulates calcification in the canine foetus under this particular set of conditions. In a series of experiments on older puppies whose diet consisted of bread, milk, meat, butter fat, and orange juice, supplemented with a salt mixture, the composition of which was based on ash analyses of milk but contained an excess of sodium and potassium, gross skeletal and dental abnormalities were observed. The dentin and pulp of the permanent teeth were extensively involved. In one animal it was found that the dentin had been so altered that its identification was impossible. The roots had become so completely resorbed that the enamel shell of a canine was lifted from the gum by a slight pull with the fingers. The pulp had degenerated into a fibrous mass.[8]

[8] Dental findings on certain animals in this series of experiments have been reported by Dr. John A. Marshall in the *Journal of the American Dental Association* (January 1924). In that communication the following statements appear in regard to the diet: "The only alteration was concerned with the proportions of calcium and phosphorus. . . . These elements were, so far as we know, the only variable factors in the whole dietary regimen. Utilizable proteids, as well as vitamins, were given in the form of meat and other fresh foods. The inorganic elements were supplied in the form of McCollum's salt mixture. . . . " Contrary to these statements, it has never been thought that the

The bread, meat, and potato diet described above was low in calcium, vitamins, and protein, and potentially basic in reaction. Compared with the bread and meat diet, on which Bitch 31 was fed for ten months before and during pregnancy, it was lower in protein and appreciably richer in minerals and vitamins, and from the latter standpoints would seem to be superior. Yet the skeletal conditions of the offspring of the mothers on the two diets were just the reverse of those expected. That the substitution of meat for potato in the diet of the mother should exert so profound an influence upon foetal calcification seems extraordinary. The most striking difference between the two diets was in their potassium contents and acid-base relations. The bread, meat, and potato diet had approximately three times as much potassium as the bread and meat diet, and an excess of base equivalent to 13 cc. of normal solution, while the latter had an excess of acid equivalent to approximately 46 cc. In metabolism studies on children, Sherman and Hawley (6) have shown that the calcium of vegetables is poorly utilized compared with that of milk. The same has been shown, by McCluggage and Mendel (7), to be true in the dog. The low coefficient of digestibility of vegetables may account for this in part, but it is also probable that the high basicity of the vegetable ash is a contributing factor to the poor utilization of the calcium salts.

In this connection the data reported by McCluggage and Mendel are interesting. In a series of experiments on two dogs, a rise in the potential alkalinity of the diet was accompanied by an increase in the excretion of calcium. A fixed amount of this element was added to a basal diet first in the form of milk, then carrots, then spinach. The milk diet of one animal had a potential acidity equivalent to approximately 11 cc. of normal solution; that containing carrots, an excess of base equivalent to 33 cc.; that containing spinach, 77 cc. of base. The calcium balances (averages of the different metabolism periods) were -0.108, -0.215, and -0.270 gram, respectively. Givens and

calcium-phosphorus ratio of the diet was an important factor in any of the experiments, since bone and dental lesions have occurred on all ratios yet employed, some of which appear to have been optimal, when the diet contained a certain preponderance of basic ions. The composition of all the salt mixtures used was based upon the ash analyses of protein-free milk made according to the directions of Osborne and Mendel with certain modifications, and not McCollum's as stated.

Mendel (8) reported that "the administration of base or acid produced no significant effect upon the balance of nitrogen, calcium, magnesium and phosphorus in the dog." Simultaneously with the appearance of their paper, Stehle (9) reported that the oral administration of hydrochloric acid, in dogs, causes an increased excretion of calcium. Kochmann and Petzsch (10), from their studies on the effect of protein, fat, and carbohydrate upon the excretion of calcium in dogs, concluded that the character of the diet influences in a large measure the retention of this element.

As early as 1873 Bunge showed that the animal organism suffers an impoverishment in chlorin when there is a surplus intake of potassium. Vegetables are extraordinarily rich in this element, and the necessity of adding sodium chloride to the diet of herbivorous animals is attributed to this fact. In view of these findings, Seeman (11) arrived at the conclusion that the high incidence of rickets among the poorer classes was due to the excessive use of vegetables, which resulted in an insufficient formation of hydrochloric acid in the stomach, and thus prevented the transformation of the insoluble calcium salts in the food into the soluble forms. In Seeman's experience, the addition of sodium chloride or hydrochloric acid to the diet of rickety children was beneficial. Subsequently, Zander (12) reported that the milk of mothers of rickety babies contained more potassium than that of mothers of normal infants. Some evidence tending to corroborate, and some to contradict, has been reported in the last half century, but no irrefutable data for or against Seeman's theory have been presented. Scheer (13) found better absorption and greater retention of calcium and phosphorus in children on an acid than on an alkaline diet. Recently Flood (14) and the writer (15) reported that certain additions of hydrochloric acid to cow-milk formulas promoted calcification in rickety children. Conversely, the addition of sodium bicarbonate to cow-milk formulas has been shown by Shohl and Sato (16) to reduce the retention of calcium and phosphorus in infants. According to these investigators, hydrochloric acid in the amounts they used had the same effect. Aub and associates (17), in their studies on lead poisoning, have also shown that the excretion of calcium as well as lead is increased by certain amounts of both acid and alkali. Zucker and Barnett (18), in experiments on rats, converted a nonrickets-

producing diet into a rickets-producing diet by the addition of sodium carbonate.

In the writer's experience (19), alterations in the acid-base balance of certain experimental diets appeared to exert a profound influence upon calcification in dogs. The absolute amount of a food constituent, organic or inorganic, within certain limits, does not seem to be a prime factor in regulating the calcifying mechanism. Certainly, the excess of base in the bread, meat, and potato diet described above was not sufficiently great, nor the mineral, protein, and vitamin content, per se, sufficiently low, to account for the failure in calcification in the offspring of Bitches 5 and 7. Yet the combination of factors contained in such a food mixture, in the absence of ultraviolet radiation, appears to exert an unfavorable influence upon the calcifying mechanism in both man and dog. Bread, meat, and potato constitute the basis of the average American dietary, and in large cities where hygienic conditions are poor and ultraviolet radiation is negligible in quantity, rickets and dental disease are almost universal. Nature appears to have combined certain factors—fruits and vegetables, which are relatively low in protein, high in minerals and vitamins, and potentially basic in reaction—with an abundance of sunshine. As the intensity of the sun's rays decreases, the diet of man tends to become higher in protein, lower in calcium, and potentially acid in reaction.

With certain combinations of food, ultraviolet radiation and hygiene appear to assume minor rôles in calcification. In this connection the Carnegie report on the Physical Welfare of Mothers and Children of Scotland is of interest. The hygienic condition of certain of the inhabitants of the Island of Lewis in the Hebrides could scarcely be worse. They live in "black houses," the walls of which are often as much as five feet thick. There is no chimney and only one opening in the house. Peat fires are kept constantly burning. Domestic animals occupy the building with the family. Chickens roost on the beds, tables, and chairs. The children are rarely ever taken out of the house until they can walk, yet rickets is almost unknown on the island; and, according to the report," the most striking fact in the adult population is their beautiful teeth—a testimony to the absence of rickets in infancy." Furthermore, the infant death-rate is among the lowest in

the British Isles, and has occasionally fallen as low as 40 per 1000. The staple articles of food are fish, oatmeal, and eggs. Milk is scarce and vegetables almost unknown. Fish liver is a favorite dish. Such a diet is high in protein and phosphorus, and low in calcium and potassium. It has a relatively high potential acidity, and is probably also rich in vitamins. Such a combination of dietary factors apparently is able to overcome the deleterious effects of poor hygiene, filth, and lack of ultraviolet radiation.

In addition to the factors already discussed, the influence of the father's diet before mating, on the composition and structure of the bones of the offspring, should be considered. The observations reported in this paper throw no light on this point, since both parents received the same diet, and lived under identical hygienic conditions in each of the experiments. Korenchevsky (20), in experiments on rats, has shown that feeding the father before mating on a diet deficient in "fat-soluble factor" had no influence whatever on the number, weight, water, calcium, phosphorus, or nitrogen content of the offspring at birth. It is conceivable that faulty diet and hygiene on the part of the father extending over a long period of time might exert a deleterious effect upon the offspring. Such experiments as these in dogs require years of time and large facilities. This is one of the many phases of the problem which remain to be studied.

Clinical and laboratory experience shows that ossification is not determined by the absolute amount (within certain limits) of any one known dietary factor, or of ultraviolet radiation. There are many interdependencies and interrelations. The ability of a cell to function seems to be equally dependent upon its integrity and its environment. It has been demonstrated that the composition of the body substance, and the structure of the bones and teeth of new-born puppies of the same litter, as well as of different litters, may vary greatly. This fact offers a logical explanation of the differences in the behavior of animals toward the same experimental procedures. Certain combinations of diet and hygiene appear to exert a favorable influence, others an unfavorable effect, upon the calcifying mechanism. The experiments reported in this paper are preliminary, and are not sufficiently numerous or varied to warrant deductions in regard to the mechanism of foetal ossification. They show, however, certain well defined

differences in the composition of the body substance, and in the structure of the bones and teeth, of new-born offspring of parents fed different combinations of common foodstuffs, and suggest new lines of attack on human problems.

IV. SUMMARY

1. Observations were made on six brood bitches and thirty-eight new-born puppies. Mothers and offspring were divided into two groups. In Group I were four large mongrel bitches, each of which had previously given birth to two or more litters, and twenty new-born puppies. The bitches and the male with which they were mated were subsequently fed quantitatively a diet of bread, lean beef, and potato. Two of the bitches were given in addition increasing amounts of sodium carbonate. All of the animals lived under identical hygienic conditions, and received a negligible amount of ultraviolet radiation.

In Group II were two bitches and eighteen new-born puppies. Eight of the latter were representatives of litters born to two bitches whose histories and dental conditions were unknown. The remainder were offspring of two bitches, one of which had been in the kennels for six weeks, and the other one year, before the birth of their young. Their hygiene was the same as that of the animals in Group I. The diet consisted of bread and meat exclusively.

2. New-born puppies of the same litters in both groups (I and II, above) showed marked differences in weight, general well-being, body ash, and structure and mineral content of the bones. Findings in general for the two groups of mothers and offspring showed certain well-defined similarities and differences.

3. The bitches in Group I, which received sodium carbonate, were not successfully bred. Dental tissue excised after they had been on the alkaline diet for one hundred and thirty days showed profound degeneration of the alveolar bone and roots of the teeth.

4. Two bitches, fed quantitatively on bread, lean beef, and potato before and during pregnancy, had convulsions during gestation and died at the time of littering. The physical condition of both animals appeared to be excellent. Their oral conditions and metabolism differed, the latter being indicated by a difference of 34 per cent in the mineral content of their offspring, although their food intakes were

exactly the same and the total weights of their young differed by only 35 grams. Physical, blood, and urine findings during pregnancy were well within the normal range. Dental tissue excised post-mortem showed degenerative changes in the roots of the teeth and alveolar bone, but the degree of involvement differed in the two animals. The diet had no effect upon the number of individuals in the litters, but the puppies were small and poorly nourished, and the total weights markedly less than those for the preceding litters. The percentage of ash in the intact bones of the offspring of one mother varied from 7.8 to 10.4 per cent, with an average of 9.4 per cent. The mineral contents of the fresh body-substance of the two litters were 1.73 and 2.09 per cent. Histologic findings in both bone and dental tissues were markedly different, in certain respects, from those observed for the puppies in Group II.

5. Chemical and histologic findings on two puppies in a litter of eight in Group II were arbitrarily adopted as "normal." The mother's early history was unknown. During the last six weeks of gestation she was fed on bread and meat. Surviving members of the litter showed no clinical or x-ray evidence of rickets at the time of weaning. The fresh intact bone of the new-born puppies contained 14.2 and 14.7 per cent of ash. Histologic findings on bone and dental tissues in the two puppies were comparable, and are described.

6. The substitution of bread and meat for a vegetable, raw-milk diet, and of restricted living quarters (with a negligible amount of ultraviolet radiation) for the freedom of a ranch and an abundance of sunshine, apparently arrested an active degenerative process in the alveolar bone of a bitch. Concomitantly, the crowns of the teeth suffered disintegration. A litter born twelve months after the bread and meat diet was instituted had an average of 14.06 per cent of bone ash, the values ranging from 11.1 to 16.1 per cent. The physical condition of the puppies was extremely poor and that of the mother excellent. Histologic findings on bone and dental tissues differed in certain respects, in the various individuals, but on the whole were comparable with those arbitrarily chosen as normal.

7. Alveolar bone from three bitches, two in Group I and one in Group II, that was obtained immediately after the birth of the litters, presented a histologic picture not commonly observed. The mineral

constituents of the compact bone and the cementum of the teeth appeared to have been leached out, leaving the corpuscles in various stages of degeneration in a matrix of fibers. The condition was not observed in biopsy tissue excised twelve months previously from one of the animals, nor in the post-mortem tissue from the two bitches in Group I that were given sodium carbonate, and not successfully bred.

8. The experiments are preliminary and not sufficiently numerous to warrant deductions in regard to foetal calcification. They show, however, that different combinations of common food stuffs, in the absence of ultraviolet radiation, exert markedly different effects upon the dentition of brood bitches, and upon the dental and skeletal development of their offspring.

The writer wishes to acknowledge, and to express appreciation for, the assistance of Dr. Zera Bolin of the Department of Pathology, University of California Medical School, in examining tissues and interpreting histologic findings.

V. REFERENCES TO LITERATURE

(1) Jones, Martha R., and Simonton, F. V. 1926 *Proceedings of the Society for Experimental Biology and Medicine*, xxiii, p. 734.
(2) Gottlieb, B. 1923 *Zeitschrift für Stomatologie*, iv, p. 195.
(3) Simonton, F. V., and Jones, Martha R. 1927 *Journal of the American Dental Association*, xiv, p. 984.
(4) Wolbach, S. B., and Howe, P. R. 1925 *Journal of Experimental Medicine*, xlii, p. 753.
(5) Mellanby, M. 1923 *British Dental Journal*, xliv, p. 1.
(6) Sherman, H. C., and Hawley, E. 1922 *Journal of Biological Chemistry*, liii, p. 375.
(7) McCluggage, H. B., and Mendel, L. B. 1918 *Ibid.*, xxxv, p. 353.
(8) Givens, M. H., and Mendel, L. B. 1917 *Ibid.*, xxxi, p. 421.
(9) Stehle, R. L. 1917 *Ibid.*, xxxi, p. 461.
(10) Kochmann, M., and Petzsch, E. 1911 *Biochemische Zeitschrift*, xxxii, pp. 10 and 27.
(11) Seeman, —. 1879 *Virchow's Archiv für pathologische Anatomie*, lxxvii, p. 299.
(12) Zander, —. 1881 *Ibid.*, lxxxiii, p. 377.
(13) Scheer, K. 1922 *Jahrbuch für Kinderheilkunde*, xcvii, p. 130.
(14) Flood, R. G. 1926 *American Journal of Diseases of Children*, xxxii, p. 550.
(15) Jones, Martha R. 1924 *Journal of the American Medical Association*, lxxxii, p. 439.
(16) Shohl, A. T., and Sato, A. 1923 *Journal of Biological Chemistry*, lviii, p. 235.
(17) Aub, J. C., Fairhall, L. T., Minot, A. S., and Reznekoff, P. 1925 *Medicine*, iv, p. 1.

(18) ZUCKER, T. F., JOHNSON, W. C., AND BARNETT, MARION. 1922 *Proceedings of the Society for Experimental Biology and Medicine*, xx, p. 20.

(19) JONES, MARTHA R. 1927 *American Journal of Physiology*, lxxix, p. 694.

———AND SIMONTON, F. V. 1926 *Proceedings of the Society for Experimental Biology and Medicine*, xxiii, p. 734.

——— AND SIMONTON, F. V. 1928 *Journal of the American Dental Association*, xv, p. 881.

(20) KORENCHEVSKY, V., and CARR, M. 1924 *Biochemical Journal*, xviii, p. 1308.

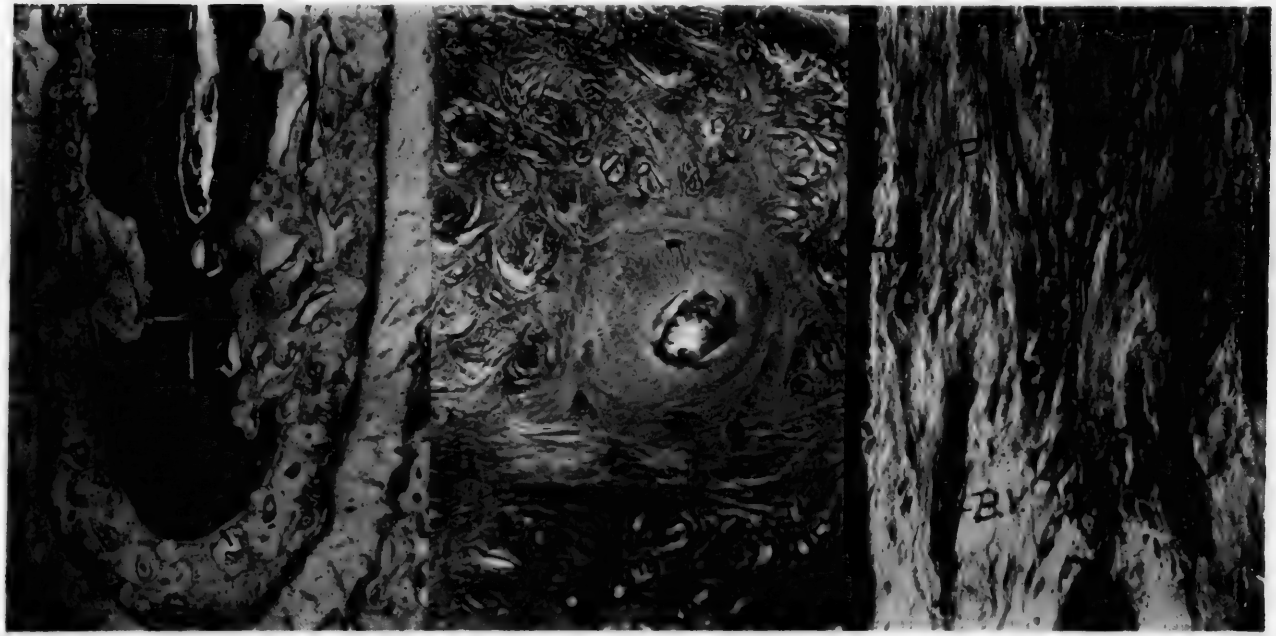


FIG. 1 FIG. 2 FIG. 3

FIGS. 1–3. BITCHES OF GROUP I

Fig. 1. Bitch 8. Post-mortem tissue. Note excavated regions in dentin and cementum, which have been filled in with haversian bone.
Fig. 2. Bitch 5. Post-mortem tissue. Alveolar bone from which inorganic constituents appear to have been leached. Note apparently intact haversian system surrounded by corpuscles in a matrix of fibers.
Fig. 3. Bitch 7. Pulp and dentin of tooth excised post-mortem. Note fibrous pulp, *P*; large blood vessels, *BV*; and absence of odontoblasts.

FIG. 4 FIG. 5 FIG. 6

FIGS. 4–6. BITCH 31 OF GROUP II

Fig. 4. Photograph of jaws. Note disintegration of tooth substance.
Fig. 5. Alveolar bone excised post-mortem. Note haversian systems surrounded by tissue from which the inorganic constituents appear to have been leached.
Fig. 6. Dentin and pulp. Tissue excised post-mortem. Compare with analogous tissue from Bitch 7 shown in *fig. 3.*

FIG. 7 FIG. 8 FIG. 9

FIGS. 7–9. PUPPY 38 OF GROUP I

Fig. 7. Costochondral junction. Note wide proliferating-cartilage zone. Trabeculae in shaft are thin and poorly defined. An osseus cylinder surrounds the enlarged cartilage cells. Compare *fig. 7* with *fig. 16* showing analogous tissue from Puppy 49, Group II.

Fig. 8. Cusp of premolar. Note thin layer of dentin, and large intercellular spaces between the odontoblasts. Compare *fig. 8* with *fig. 17* showing analogous tissue from Puppy 49.

Fig. 9. High magnification of coronal region of pulp and dentin. The odontoblasts are scattered, and the intercellular spaces large. The predentin layer is poorly defined. Scarcity of blood vessels is conspicuous.

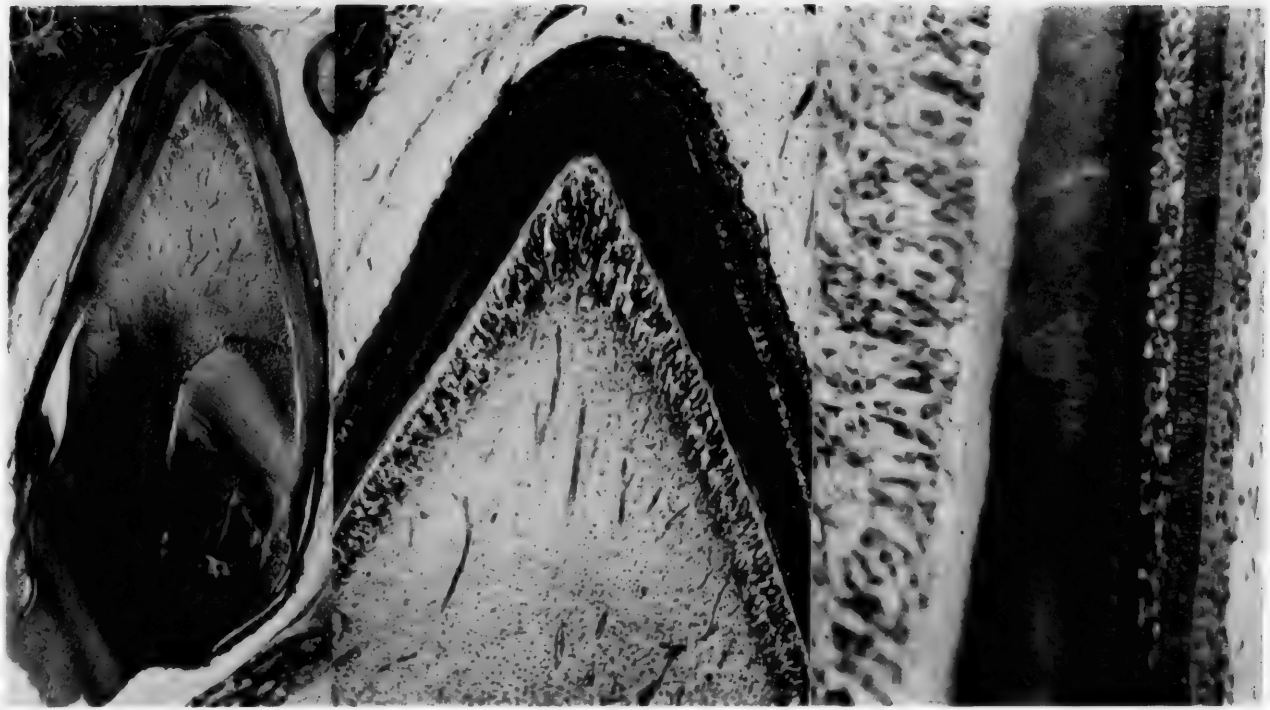


FIG. 10 FIG. 11 FIG. 12

FIGS. 10–12. PUPPIES OF GROUP I

Fig. 10. Lower canine of Puppy 22. Note large mass in pulp. It has been irregularly laid down, and in the interior is a clump of odontoblasts. It is also surrounded by cells. The odontoblasts bordering the pulp are bunched together, leaving large intercellular spaces. Compare with *fig. 13*.

Fig. 11. Cusp of premolar of Puppy 23. The dentin layer is relatively thin, and odontoblasts are irregularly arranged. There is also a disturbance in the enamel-forming mechanism.

Fig. 12. High magnification of a lateral region of canine of Puppy 23. The odontoblasts are scattered and irregularly arranged, and separated from the predentin layer by a space transversed by fibrils. The ameloblasts are also separated from the enamel matrix by a network of fibers, in which enamel globules are scattered.

FIG. 13 FIG. 14 FIG. 15

FIGS. 13–15. PUPPIES OF GROUP II

Fig. 13. Canine of Puppy 43. *A*—ameloblasts; *E*—enamel; *D*—dentin; *O*—odontoblasts; *P*—pulp. Note large blood vessels, densely packed; orderly arranged odontoblasts; relatively thick layer of dentin. Compare with *fig. 10*.

Fig. 14. Coronal portion of canine of Puppy 42. The ameloblasts in places are separated from the enamel matrix.

Fig. 15. High magnification of a lateral region of canine of Puppy 43. Compare with *fig. 12*.

FIG. 16 FIG. 17 FIG. 18

FIGS. 16–18. PUPPY 49 OF GROUP II

Fig. 16. Costochondral junction. Compare with *fig.* 9, which shows comparable tissue from Puppy 38, Group I.
Fig. 17. Cusp of premolar of Puppy 49. Compare with *fig. 8.* Note the densely packed, orderly arranged odontoblasts; and relatively thick layer of dentin. The ameloblasts are separated from the enamel matrix in places.
Fig. 18. High magnification of a coronal portion of pulp and dentin of tooth shown in *fig. 17.* Compare with *fig. 9.*

CONCERNING DEFECTS IN THE ENAMEL OF TEETH OF ANCIENT AMERICAN INDIANS[1]

CHARLES F. BÖDECKER, D.D.S., F.A.C.D.

Laboratory of Oral Histology and Embryology, Columbia University Dental School, New York City

Enamel fissures, or flaws in the protective covering of the teeth, are considered to be of modern origin. It has been thought that the unbalanced diet of civilized man, or possibly his changed mode of life, has some evil influence on the formation of dental enamel, resulting in defects in the protective covering of the teeth. This, however, does not seem to be the case. An interesting light was thrown upon this subject by an examination of teeth of Pueblo Indians of New Mexico, who are supposed to have lived 800 or 900 years ago.[2] This examination disclosed the rather startling fact that many of these teeth contained typical enamel fissures. Doubt consequently arose temporarily in my mind as to the correctness of the claim of Thaddeus P. Hyatt, who maintains that enamel fissures predispose teeth to decay. Such a supposition *appeared* to be disproved, for this collection of 317 teeth showed less than 3 per cent of dental decay! The paradox of the presence of enamel fissures, and of a very low incidence of dental caries, will be explained in this paper.

The twenty occlusal surfaces of the teeth of *civilized* man show a frequency of decay greater than on all the remaining one hundred twenty-eight surfaces! Enamel fissures, being real defects in the protective covering of the teeth, are commonly found on the occlusal areas, and are held responsible for the increased liability of these sur-

[1] Read at a session of the Eighth General Meeting of the International Association for Dental Research, Royal York Hotel, Toronto, Canada, March 24–26, 1930. See abstract: *Journal of Dental Research*, 1930, x, p. 377.

[2] These teeth were sent to Dr. Henry W. Gillett by Dr. A. B. Kidder of Amherst College, one-time chairman of the National Research Council at Washington, D. C. Dr. Gillett in turn presented these teeth to the Columbia University Dental School for investigation.

faces to decay. These flaws are most frequently found as minute crevices leading into poorly calcified areas in the enamel. Many of these fissures are, in fact, so deep that they penetrate completely through the enamel to the dentino-enamel junction. In many in-

FIG. 1. Photomicrograph of a ground section of a modern human molar, showing incipient decay of an enamel fissure, bridged over by a mucigen plaque (*P*). *E*, enamel. *D*, dentine.

stances these defects are also so minute that even a single tooth-brush bristle cannot penetrate into their depths. As a result, the individual cannot keep such areas clean, and they become packed with food debris and bacteria covered by mucigen plaques (*fig. 1*). The food of civilized man contains a high percentage of carbohydrates, including

particularly sugar, and the highly refined and almost impalpably ground white flour, which rapidly ferment and form lactic acid as one of their products. This acid dissolves the mineral contents of the enamel, and thus a minute cavity is formed. The principal, determining *external* factor of dental decay appears to be the retention of food and specific bacteria in contact with the teeth. This condition is ideally fulfilled by the morphological form of enamel fissures.

FIG. 2. Molars and premolars of young members of the Pueblo tribe, Pecos, New Mexico, which show serious enamel defects. (Specimens obtained from Dr. A. B. Kidder through Dr. Henry W. Gillett.)

FIG. 3. Two lower molars of individuals who lived approximately in 1100 A.D., found in Turkey Hill, Arizona, showing exceedingly deep buccal and occlusal enamel defects.

The *smooth* surfaces of teeth, that is, those having no grooves, pits, sulci, or fissures, do not readily decay, unless the close proximity of a neighboring tooth allows food to be retained. That is the reason why the smooth surfaces of teeth decay principally on the approximal areas where they come in contact with the adjoining teeth.

The macroscopic examination of teeth of young Pueblo Indians disclosed typical enamel fissures. *Fig. 2* shows a photograph of ten

molars and two pre-molars, of this tribe, in approximately natural size. The fact that these belong to young individuals is indicated by the incomplete development of the roots, as well as by the slight degree of abrasion of the occlusal surfaces of the crowns. Modern

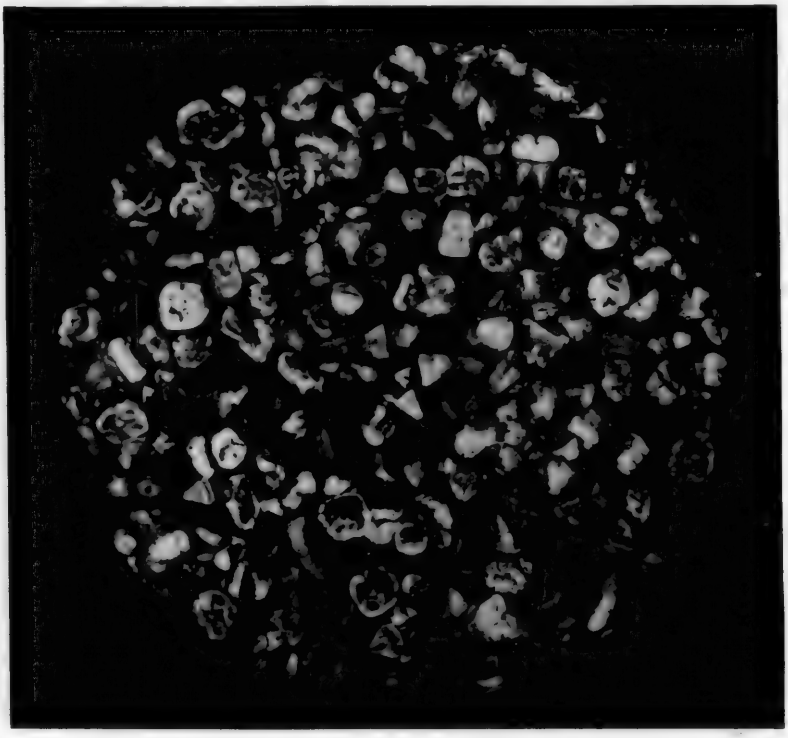


FIG. 4. Three hundred seventeen teeth of the Pueblo tribe of Pecos, New Mexico, showing less than 3 per cent of decay in spite of enamel defects.

teeth show no greater or more typical development of enamel defects than these teeth of ancient Indians.

Fig. 3 shows two lower molars of Indians living in approximately 1100 A.D., found in Turkey Hill, Arizona.[3] They have exceedingly deep buccal fissures as well as occlusal defects. As the apices of the

[3] Sent to Dr. Henry W. Gillett by Mr. E. W. Hanry, Tucson, Arizona.

roots had been completed, the individuals they represent were older than those of the previous illustrations, but the extent of the abrasion of the occlusal surfaces is minimal, indicating that these members of the tribe were still comparatively young.

In order to prove that the defective teeth previously shown were by no means exceptions, and to demonstrate that the incidence of dental decay was exceedingly low, 317 teeth of the Pueblo Tribe of

FIG. 5. Photomicrograph of a ground section of a lower molar of a young member of the Pueblo tribe, showing serious enamel defects extending to the dentine.

New Mexico were photographed (*fig. 4*). This collection contains many young teeth, with incomplete roots and marked enamel fissures; somewhat older teeth, in which these defects were slowly being obliterated by the force of mastication; and finally, others in which not a trace of enamel defect remains. This appears to indicate that most of the young teeth of the ancient Indians contained fissures, but that these rarely decayed and were finally obliterated by abrasion.

Fig. 5 is a photomicrograph of a ground section of a lower molar of a Pueblo Indian. It must be from a young individual as there are no signs of abrasion. Various types of enamel defects, which we note in the teeth of civilized man to-day, are here seen in one section. A

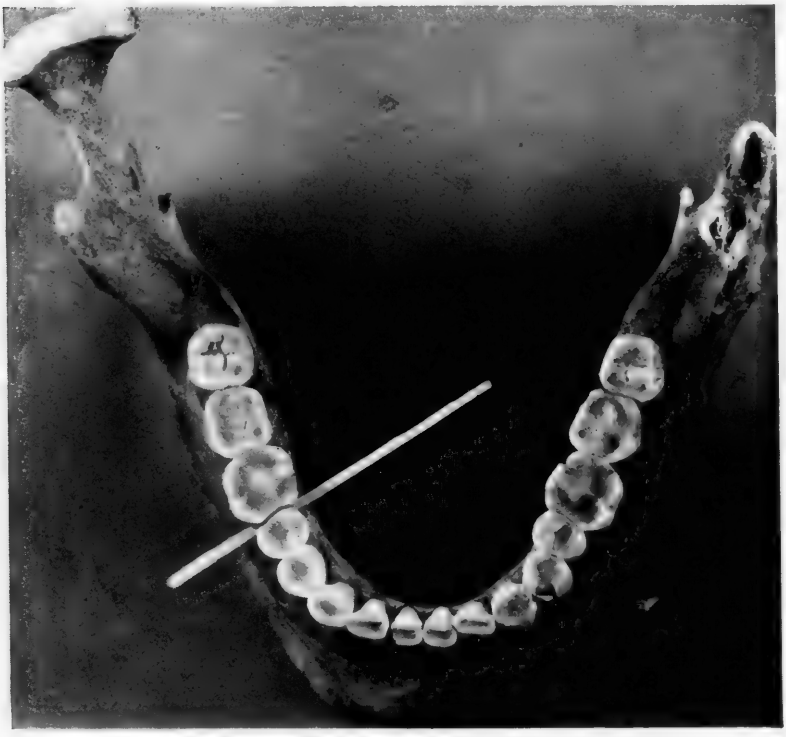


FIG. 6. Photograph of a human mandible found at Kampsville, Ill.; sent to Dr. Gillett by Mr. Taylor. The teeth are excessively abraded, excepting the recently erupted third molars, which show marked enamel fissures. The individual movement of the teeth has even worn the approximal areas.

deep fissure extends almost to the dentine, and there are areas of imperfect calcification of the enamel. Such defects in the protective covering of the teeth to-day undoubtedly lead to their early decay.

Fig. 6 shows a human mandible that was exhumed at Kampsville, Illinois.[4] Here we note a perfect complement of sixteen teeth having

[4] Sent to Dr. Henry W. Gillett by Mr. J. L. B. Taylor, Urbana, Ill.

no trace of decay. Mastication has been so vigorous that all enamel fissures, except in the third molars, have been obliterated. Again typical enamel fissures are shown in the third molar, indicating that like defects were present in the other molars and bicuspids, but that they had been obliterated by the stress of mastication, causing the underlying dentine to be exposed. Judging by the varying degree of abrasion between the first, second, and third molars, we come to the conclusion that this individual died at the approximate age of 25 or 30 years.

The observation that the Pueblo Indians did not suffer from a high frequency of dental caries, in spite of the fact that their teeth contained numerous typical enamel fissures, was disconcerting to our present views. On the basis of this fact, it might be concluded that enamel fissures do not predispose the teeth to decay. *This conlusion is unwarranted, however, when applied to the teeth of civilized man.* There are three reasons why the teeth of the Pueblo Indians did not decay, in spite of the apparently defective enamel. These reasons are:

(a) They indulged in thorough and energetic mastication of coarse, gritty food.

(b) They lived on natural unrefined diet.

(c) The tribe enjoyed normal health, which maintained the local resistance of the teeth to decay.

(a) One of the principal foods of the Pueblo Indians appears to have been maize (corn), ground by hand in stone mortars. Dr. Gillett informs me that there was a saying among this tribe that each individual consumed, during his span of life, one stone mortar and two stone pestles, which must have given a very gritty consistency to his food. Thorough mastication appears also to have been a general peculiarity of this tribe, judging from the good development of the mandible and the broad attachment of the muscles of mastication. Gritty food, particularly when energetically masticated, caused excessive abrasion of the occlusal surfaces of the teeth. *Fig. 6* shows such excessive abrasion in the teeth of a mandible of a young person as is rarely found today, even in an individual 60 years of age.

The rapid and excessive abrasion of the occlusal surfaces of the premolars and molars had, as a natural consequence, the early obliteration of the enamel fissures. Judging by the examined specimens, it is

believed that, after a period of three to five years, all fissures on the occlusal surfaces were obliterated. But even this early obliteration of the enamel fissures does not explain why decay did not enter these areas during the first three years after the eruption of the teeth, for that is the period, in our civilized times, in which decay of the teeth is most rampant. There is no doubt, that food could collect in the enamel fissures of the teeth of the Pueblo Indians, just as it does today in the teeth of civilized man. Our modern tooth brush was of course unknown. No indications exist that they used a "miswak" like that commonly employed by the Zulus of Africa today. But even if they did use an implement to clean the teeth, it could not have been efficacious in removing food debris from the depth of the fissures. Therefore it must be concluded, that food was retained in the fissures, and had ample opportunity to ferment (if it was fermentable), yet very little decay resulted.

(b) The food taken by this tribe consisted principally of corn, ground by hand in stone mortars. Such a mode of preparation could only furnish corn meal of an exceedingly coarse variety. It could not be accused of the serious shortcomings of our highly refined flour of today, which is ground into an almost impalpable powder, and readily lodges in the tiniest crevices of a tooth. The enamel fissures in the teeth of the Pueblo Indians were therefore not filled with extremely refined wheat flour, and highly fermentable sugar. Thus we have a second reason why dental caries was not common in the teeth of the Pueblo Indians.

(c) The health of the tribe was probably excellent, as a result of living on a natural diet, and having ample sunshine and sufficient exercise. This resulted in maintaining the normal, local resistance of the teeth to dental decay. The claim that bodily conditions can have an influence upon the welfare of the teeth is by no means proven, although I, as well as my father and brother, have long maintained this to be a fact. The acceptance of this theory was an impossibility, as long as the old conception of the enamel was maintained. In the old view of the chemical composition of the adult enamel, this tissue was almost wholly inorganic in nature and it was even denied the term "tissue." There has been a demonstration, however, of a considerable

amount of protein matrix[5] in adult enamel (varying from 20 to 40 per cent in *volume*). It has also been shown, by laboratory and animal experiments, that fluids can diffuse from the dental pulp into the enamel and into its protein matrix. These discoveries opened the way for a more rational conception of the teeth. The fluid present in the dentine and enamel originates from the pulp of the tooth, which is richly supplied with blood vessels.

Up to the present, the completed and fully erupted tooth has been denied the necessity of any nourishment, in spite of the profuse blood supply found in the pulp. This however, it is hoped will soon be proved, and then the comprehension of the relation of the teeth to the body will be entirely changed. Possibilities of the diffusion of blood plasma through the dentine and the enamel make it conceivable that bodily conditions can affect the welfare of the teeth.

And thus the health of the individual supplies a third reason why the teeth of the Pueblo Indians were not ravaged by dental caries, in spite of the fact that they contained numerous enamel defects.

Summary

The conclusions to be drawn from the examination of the teeth of some of the older tribes of America are these:

1. Enamel fissures or defects in the protective covering of the teeth were present to as great a degree as they are in the teeth of individuals of today.

2. Enamel defects did not, at that time, predispose these teeth to decay, as shown by the fact that the incidence of dental caries was exceedingly low.

3. The force of mastication of gritty food must have been considerable, judging from the degree of abrasion, and far beyond anything seen today in the teeth of civilized man. The intensity of this abrasion is not only shown on the occlusal surfaces, but also in the approximal areas (*fig. 6*). The individual movement of the teeth (which is again doubted by one investigator) has abraded the approxi-

[5] Bödecker C. F.: Enamel of the teeth decalcified by the celloidin decalcifying method, etc. *Dental Review*, 20; April, 1906. Bödecker, C. F. and Gies, W. J.: Histochemical proof of the presence of protein matter in dental enamel. *Proceedings of the Society for Experimental Biology and Medicine*, 22; Dec., 1924.

mal surfaces to such a degree that, in certain places, the entire enamel has been worn off, exposing the underlying dentine. In spite of the exposure of this more vulnerable tissue between the teeth, no decay resulted. This is an added proof of the presence of a mysterious immunity to dental caries, which to my mind will be found in the health of the individual.

4. Even though enamel fissures did not apparently dispose the teeth of the ancient Indians to decay, this thought must certainly not be applied to the teeth of civilized man. Here they are an active predisposing factor, on account of the highly refined, pappy, acid-forming food of today, and the lower degree of vitality of the body, resulting in an impaired resistance of the dental tissues to decay.

5. Enamel fissures must therefore be treated early in order to maintain the teeth of civilized man in a more healthy condition.

THE EPITHELIUM IN DENTAL GRANULOMATA[1]

THOMAS J. HILL, D.D.S.

Institute of Pathology and the School of Dentistry, Western Reserve University, Cleveland, Ohio

A dental granuloma is a chronic apical periodontitis characterized by the formation of a localized nodule of inflammatory tissue. Histologically, the granuloma essentially consists of an edematous moderately collagenous connective tissue, infiltrated with a variable number of lymphocytes, plasma cells, large mononuclear and polymorphonuclear leucocytes. Many contain large or small islands of stratified squamous or cuboidal epithelium.

It has been assumed that bacterial invasion of the apical periodontal membrane will result in the formation of a dental granuloma. The recovery of bacteria from mature granulomata by Rosenow (1), Haden (2), Price (3), and others does not, in the majority of cases, prove their etiological relationship, since any organism recovered from a fully developed granuloma may be a secondary invader. The experimental production of granulomata in animals should aid in the solution of this problem.

The origin of the squamous epithelium often found has been the subject of controversy. Two theories have been advanced to explain it. Partsch (4) and Witzel (5) suggested that it arose from rests of the enamel organ. Grawitz (6) believed that, in the majority of cases, it developed from epithelium which invaded the granuloma by way of a fistulous tract from the buccal cavity. The main support of Partsch's theory has been the close association of enamel-organ rests with granulomata. So far as we are aware, there is little histological evidence to establish their identity. The hypothesis of Grawitz depends upon the known frequent suppuration, and establishment of fistulae to the buccal cavity. Numerous investigators have observed short epithe-

[1] Received for publication March 10, 1930. Presented at a session of the Eighth General Meeting of the International Association for Dental Research, Royal York Hotel, Toronto, Canada, March 24–26, 1930. See abstract in this issue: *Journal of Dental Research*, 1930, x, p. 401.

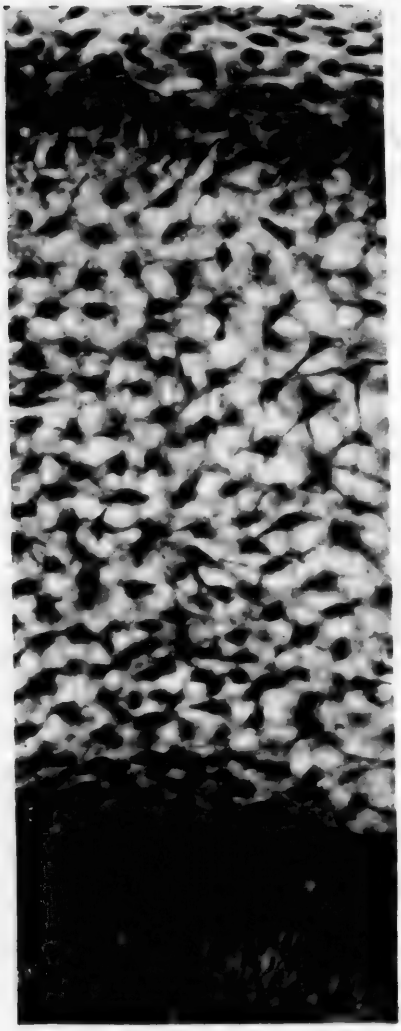


FIG. 1

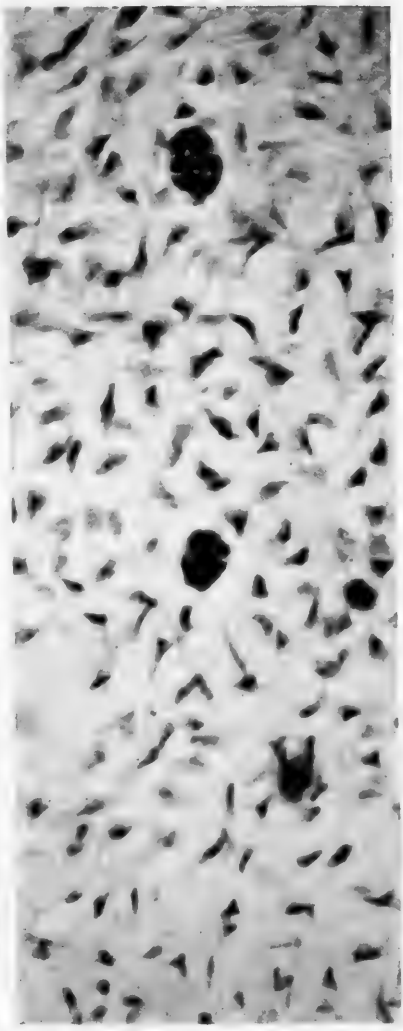


FIG. 2

FIG. 1. The normal enamel-organ of a lower central incisor, to show the stellate network of the enamel pulp. Hematoxylin and eosin. ×440

FIG. 2. Enamel rests of Malassez. Hematoxylin and eosin. ×690

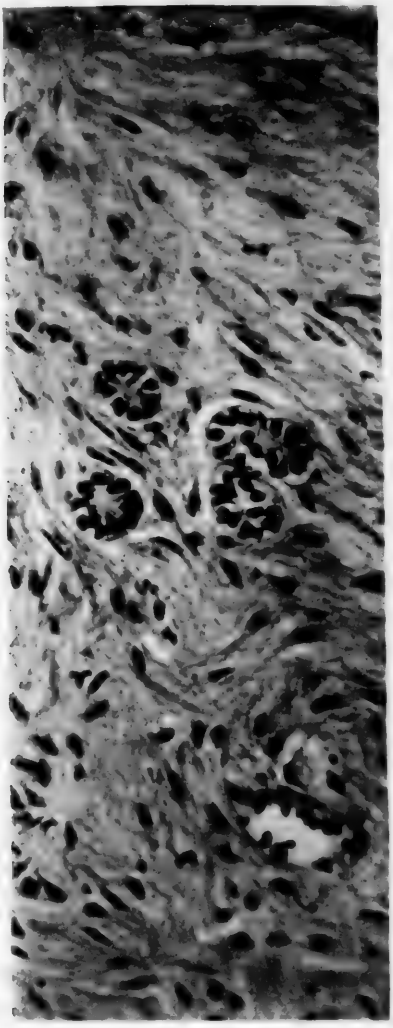


FIG. 3

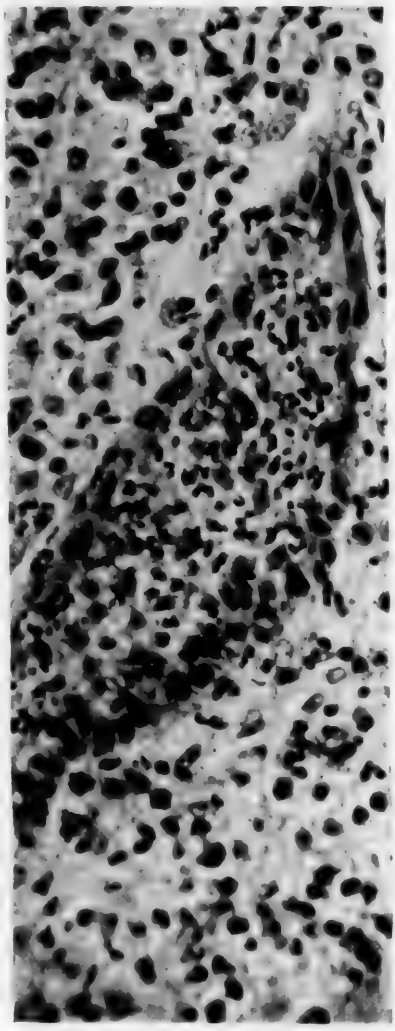


FIG. 4

FIG. 3. Clusters of epithelial cells in a granuloma. These cells resemble the rests of Malassez. Hematoxylin and eosin. ×410

FIG. 4. Proliferated epithelium within a granuloma. An illustration of the concentration of polymorphonuclear leucocytes within the epithelium. Hematoxylin and eosin. ×410

lial cords from oral mucosa, but complete continuity between the surface and the granuloma has not been demonstrated.

In the present study the histological structure of one hundred and thirty-one (131) dental granulomata has been investigated, with special attention to their epithelial content. Routine sections have been studied in eighty-nine (89) cases, and serial sections in forty-two (42). The interval between extraction and fixation did not exceed fifteen

FIG. 5

FIG. 6

FIG. 5. Strand of proliferated epithelium. Hematoxylin and eosin. ×50

FIG. 6. Epithelial mass with cystic degeneration of the central portion. Foot-Bielschowski stain. ×50

minutes in any instance. The tissues were fixed in Zenker formol or 4 per cent formaldehyde, dehydrated, and embedded in paraffin. Sections were stained with van Gieson's fuchsin-picric acid, MacCallum's bacterial, Mallory's aniline blue, and Foot's reticulum stain, and hematoxylin and eosin. For the comparison of cell types, we have studied decalcified sections of embryonic and adult normal teeth.

In the enamel organ, the cells that line the invaginated portion are columnar in shape, and known as ameloblasts or internal epithelium. At the base of the internal epithelium is a layer of polygonal cells,

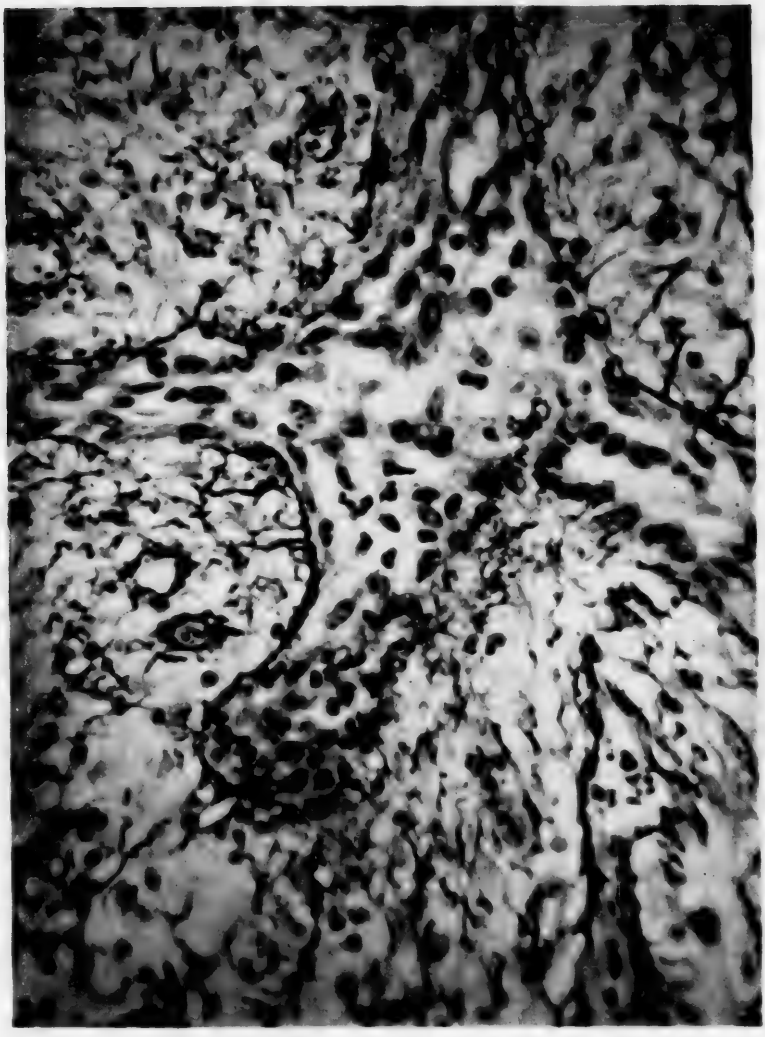


FIG. 7. The stellate syncytium within proliferated epithelium. Note its resemblance to the stellate network of the enamel pulp (*fig. 1*). Foot-Bielschowski stain. ×410

called the intermediate stratum. The external epithelium covering the outside of the enamel organ consists of polygonal cells. Between the external and intermediate strata the cells form a loose network known as the enamel pulp (*fig. 1*).

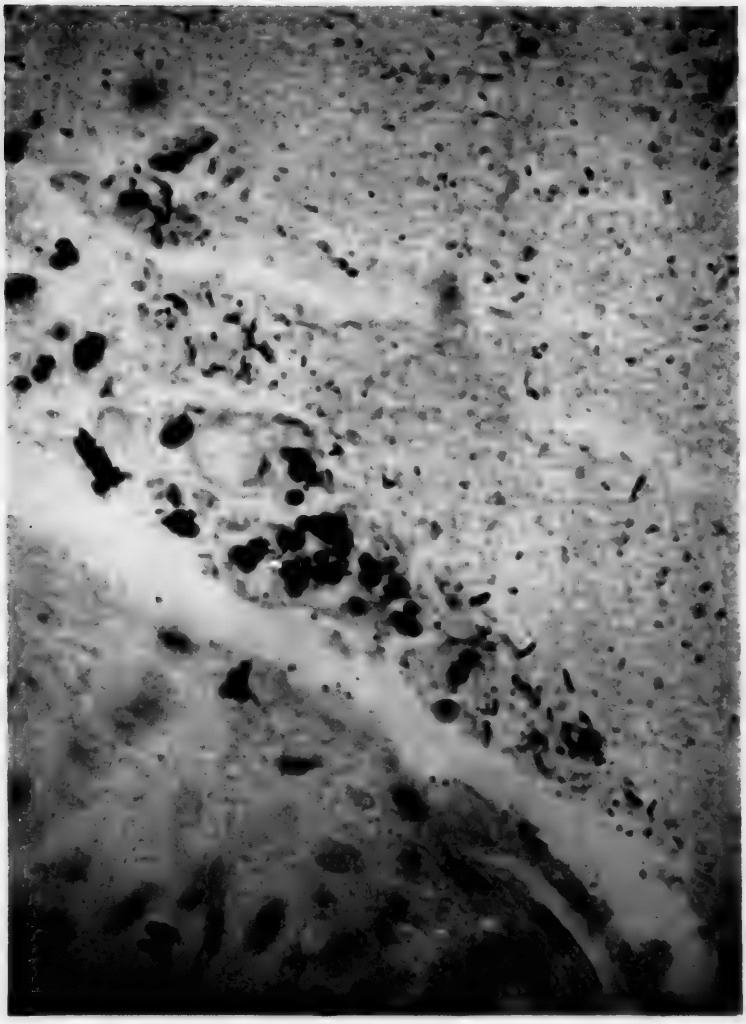


FIG. 8. Bacteria within the necrotic epithelium of the granuloma shown in *fig.* 7. Maccallum bacterial stain. ×950

The enamel organ is avascular, although the tissue immediately about it is highly vascular. From this area small capillaries, surrounded by a sheath of connective tissue and epithelium, penetrate

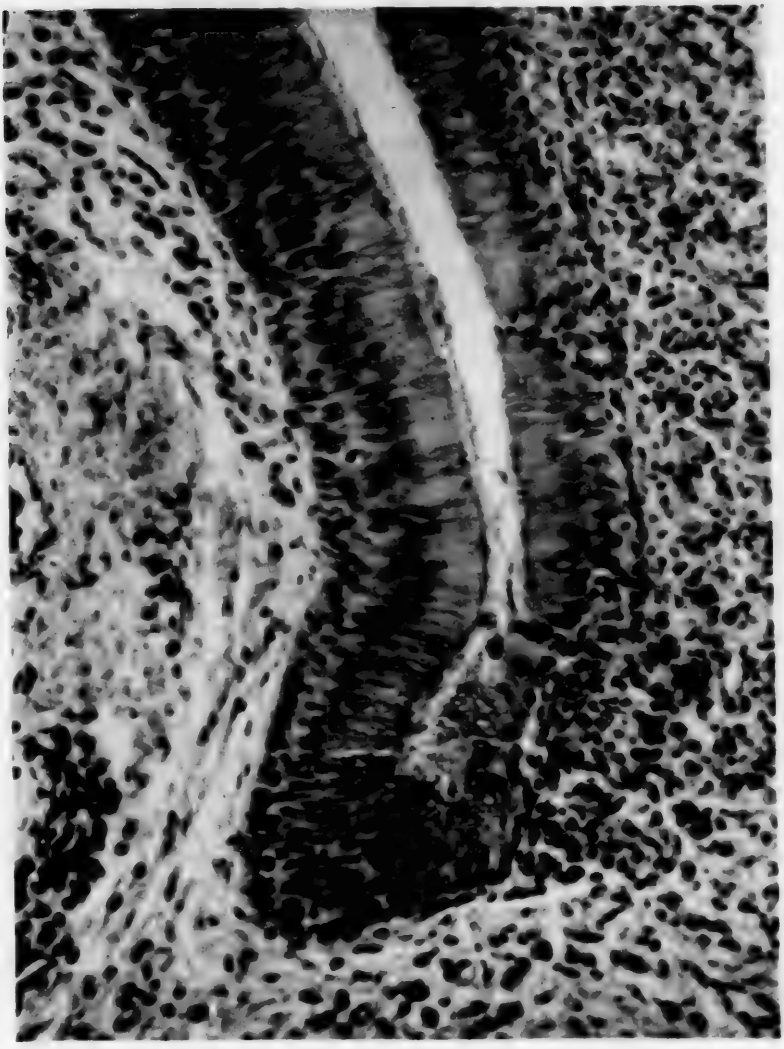


FIG. 9. Ciliated epithelium in dental granuloma. Hematoxylin and eosin. ×310

into the pulp for a short distance. The internal epithelium covering the region of the future crown forms enamel. Over the developing root the internal and external epithelial layers are approximated, and

form Hetwig's sheath. With the completion of the development of the root, Hetwig's sheath becomes fragmented, and it would appear that it partially degenerates and is absorbed. The cell groups that remain are called the enamel rests of Malassez (*fig. 2*).

McConnell (7) found epithelium in 33 per cent to 35 per cent of granulomata. The eighty-nine routine sections cut in this laboratory gave similar results. This finding is difficult to correlate with the work of Dependorf (8) and Malassez (9), who reported epithelial rests as constant in the normal periodontal membrane. Because of this, we have examined serial sections of forty-two granulomata, and found epithelial tissue in every case. The epithelium may be present in the form of small discrete acini composed of six to twelve cuboidal cells, resembling the rests of Malassez, but is usually found in larger masses.

The small epithelial acini are found in an area composed of large numbers of young fibroblasts, with occasional polymorphonuclear and plasma cells (*fig. 3*). There may also be a slight proliferation of the epithelial cells, accompanied by an increase in number of the polymorphonuclear cells in or surrounding the epithelium. With each occurrence of large epithelial islands, an increase in the polymorphonuclear infiltration is observed. As epithelial islands of greater size are found, the concentration of polymorphonuclear infiltration becomes greater within the epithelium than in the surrounding tissue (*fig. 4*). These islands of epithelium are demonstrable in all stages of proliferation, from the epithelial rests to large areas with cyst formation. As the epithelium proliferates, it forms strands extending into the surrounding tissue. These strands are composed of a double row of epithelial cells, between which is a stellate syncytium (*fig. 5*). The layer of epithelial cells that borders the epithelial cords and islands in the granuloma bears a resemblance to the layer of external epithelium of the enamel pulp, and the stellate syncytium between the two layers of epithelial cells has marked similarity in its morphological and staining characteristics to the pulp of the enamel organ. This morphological resemblance has been observed by Rywkind (10), although we cannot agree with him that it is characteristic of all proliferations of the epithelium of the buccal mucosa. By the use of Foot's modification of Bielschowski's stain, reticulum and collagen can be demonstrated throughout the granuloma, except within the epithelium and

its stellate pulp (*fig. 7*). By the use of the same stain, the stellate network between the two epithelial layers can be shown to be a true syncytium. This epithelium is avascular, although occasional invaginations of the surrounding tissue carrying blood vessels with it are found. On cross sections these appear as vessels within the epithelium, but careful examinations with special stains shows collagenous connective-tissue surrounding the vessel.

Partsch (4) believed that the cystic areas within granulomata were the result of a hydropic degeneration of the connective tissue, and that the epithelium developed within these areas. McConnell (7) supported this theory, and expressed the opinion that the epithelial covering was in the nature of a protective reaction. Our observations confirm those of Römer (12) and Rywkind (11): the primary areas of cyst formation are within the epithelium, and are the result of necrosis of the center of the epithelial masses, consequent to the avascularity and poor nutrition of this tissue (*fig. 6*). Various amounts of epithelium remain around the cystic spaces. It is usually of a squamous type but may, in some areas, occur as a single row of cells or be entirely destroyed.

Sections prepared by MacCallum's triple stain, from one hundred granulomata reported in the present study, have been examined for bacteria. Although histological evidence of pyogenic inflammation is almost always associated with proliferated epithelium, demonstrable bacteria are confined to areas of necrosis and the immediately adjacent tissue (*fig. 8*). Previous investigators, with the exception of Euler (12), gave little consideration to the relation of bacteria to definite areas of pathological change, and reported only the general bacterial content.

In this study of one hundred and forty-two granulomata, two were found that contained spaces lined by tall, columnar, ciliated epithelium (*fig. 9*). Römer (12), Hopewell-Smith (13), and Baker (14) have made similar observations. Baker (14) believed this epithelium to be a transition from the squamous type. We agree with Römer (12) that it is derived from the epithelium of the maxillary sinus. Such a view is supported by histological similarity, and in our experience by its restriction to teeth in immediate contiguity with the antrum.

CONCLUSIONS

1. All granulomata contain epithelium.

2. Not only are there morphological similarities between the proliferated epithelium of dental granulomata and the embryonal enamel-organ, but actual transition from enamel-organ rests to proliferated epithelium in dental granulomata has been demonstrated.

3. Granulomata occasionally contain epithelium which appears to be derived from that of the maxillary sinus.

4. The cystic areas within the granulomata are the result of epithelial necrosis.

5. There is an association of proliferated epithelium and polymorphonuclear leucocytic infiltration.

6. Bacteria can be demonstrated in tissue sections only in areas of necrosis.

The author wishes to express appreciation for the aid of Dr. H. T. Karsner in the preparation of this paper.

REFERENCES TO LITERATURE

(1) ROSENOW, E. C. 1919 Studies on elective localization, *J. Dental Res.*, *1:* 205.

(2) HADEN, R. L. 1925 The pulpless tooth from a bacteriologic and experimental standpoint, *J. Amer. Dent. Assoc.*, *12:* 918.

(3) PRICE, W. A. 1923. Dental infections. Pelton Publishing Co., Cleveland.

(4) PARTSCH, C. 1910 Zur Pathogenese der Kieferzysten, *Deutsche Med. Wchnschr.*, *34:* 1009.

(5) WITZEL, J. 1896 Über Zahnwurzelcysten, deren Entstehung, Ursache und Behandlung, *Deutsche Monatschr. f. Zahnh.*, *14:* 305.

(6) GRAWITZ, P. A. 1906 Die Epithelführenden Zysten der Zahnwürzeln. Greifswald.

(7) MCCONNELL, G. 1921 The histo-pathology of dental granuloma, *J. Amer. Dent. Assoc.*, *8:* 390.

(8) DEPENDORF, T. 1912 Zur Pathogenese der Zahnwurzelzysten, *Deutsche Monatschr. f. Zahnh.*, *30:* 809.

(9) MALASSEZ, M. 1885 Sur le rôle des debris Épithéliaux paradentaires, *Arch. de Physiol.*, *5:* 129.

(10) RYWKIND, A. W. 1927 Die Bedeutung des Deckepithels des Mundhöhle für die Morphologie und Pathologie des paradontalen produktiven Vorgänge, *Deutsche Monatschr. f. Zahn.*, *45:* 673.

(11) RÖMER, O. 1928 Handbuch der path. Anat. und Hist., *4* (Part 2): 348. Julius Springer, Berlin.

(12) EULER, H. 1927 Periapikale Herde in ihrer Bedeutung für die fokale Infektion, *Deutsch. Monatschr. f. Zahn.*, *45:* 683.

(13) HOPEWELL-SMITH, A. 1918 Normal and pathological histology of the mouth, *2.* Blakiston Sons & Co., Philadelphia.

(14) BAKER. 1928 See Hopewell-Smith: *Ibid.*, p. 262.

NOTES ON THE NEURO-HISTOLOGY OF THE PULP OF A HYPERSENSITIVE TOOTH

LESTER RICHARD CAHN, D.D.S.

Department of Oral Pathology, School of Dental and Oral Surgery, Columbia University, New York City

Miss K. complained of pain in the right lower jaw arising specifically from the lower second bicuspid tooth. Examination of this tooth revealed a small occlusal amalgam filling, and a slight break in the enamel of the buccal cusp. Application of an explorer to this very small cavity caused a great deal of pain. It was impossible to excavate the trivial amount of decay without the use of a local anesthetic. Since the tooth was so sensitive, it was thought that the pulp must be diseased. Accordingly, the pulp was removed under a mandibular injection. The caries barely penetrated the enamel into the dentine. The pulp was prepared by the author's modification of the Cajal-DeCastro method for staining nerve fibres and trunks.

Fig. 1 shows a nerve trunk passing through the substance of an area of calcification. *Fig. 2* depicts a trunk passing between two islands of calcification, and directly conforming to the outline of one of them.

Comment. Calcifications in the dental pulp have long been thought to cause pain directly and reflexly, by exerting pressure on nerve trunks and nerve fibres. This has been merely a deduction without concrete proof. However, the sections made from the pulp in the case just described prove this conception to be correct.

In studying sections of pulps stained by this special technique, I have been amazed to find the enormous amount of nerve tissue present. For an organ its size, it is probably more innervated than any tissue in the body. From clinical experience we all know how sensitive the pulp is to manipulation. The lay term "nerve" is well applied.

Calcification is the most prevalent lesion of the dental pulp. It is hard to see how, with the amount of nerve fibres present, any calcification of even medium size could miss engulfing or impinging on these neurites.

FIG. 1. Section of the hypersensitive pulp. *A*, area of calcification, *B*, a nerve trunk passing through the substance of the calcification. (Compare diagram with photomicrograph.)

We can readily understand how the slightest cavity enables an irritation—bacterial, chemical, or thermal—to be conveyed through

FIG. 2. Section of the hypersensitive pulp. *A*, *B*, islands of calcification. *C*, a nerve trunk passing between these two islands. At *D*, the nerve trunk is conforming to the outline of the calcified area, *A*. (Compare diagram with photomicrograph.)

the dentinal tubules to the pulp, causing swelling of the tissue and consequent pressure of calcified areas against neurites or nerve

trunks. The pressure against the nerves causes either a local neuritis, felt as a hypersensitivity of the tooth (irritable pulp), or a neuralgia, expressed reflexly in a distant, but neurologically related, part.

Summary. A case of extreme hypersensitivity of a tooth with reflex pain is presented. The tooth had a small shallow amalgam filling, and a minute break in the enamel of the buccal cusp. Any irritant applied to this enamel-break caused intense pain.

The pulp was removed under local anesthesia, and stained by a modification of the Cajal-DeCastro method for bringing out neurites and nerve trunks.

Sections of the pulp revealed calcified areas in close relationship with nerve fibres and trunks.

Photomicrographs show a nerve trunk passing through the substance of a calcified area, and a trunk passing between two areas of calcification and being impinged upon by one of them.

These sections prove the correctness of the hypothesis that calcifications in the pulp impinge on and engulf neurites and nerve trunks, causing localized neuritis (hypersensitivity) and reflex neuralgia.

CLINICAL ORAL SURGERY, WITH SPECIAL EMPHASIS ON ITS RELATED PATHOLOGY: PART THREE[1,2]

THEODOR BLUM, D.D.S., M.D. (Penn.), Universae Medicinae Doctor (Vienna), F.A.C.D., F.A.C.S.

New York City

CONTENTS

I. Introduction 337
II. Absorption at the neck of a root in a case of impaction 338
III. Hypercementosis or cementoma 342
IV. Odontoma 347
V. Giant-cell tumor 354
VI. Osteogenic sarcoma 357
VII. Epidermoid carcinoma; adenoidcystic type 363

I. INTRODUCTION

In previous papers by the writer, under the title of "Clinical oral surgery,"[2] an attempt was made to present interesting cases with pathological findings. These reports were received from laboratories not conducted exclusively in conjunction with the author's office and hospital practice. It will easily be understood that such a combination is important for the study of the pathology of the teeth and jaws. Even if pathologists did not specialize in different branches, the oral cavity should certainly be selected as a special field, because of the particular histological make-up of the structures found therein. In accordance with this belief, a laboratory for this exclusive purpose was established by the author about one and a half years ago. Its director specializes in this field only, although routine blood examinations and urinalyses, smears, etc., are also taken care of there. The results obtained have been most satisfactory, and I am quite sure that many conditions are now much more clearly understood and appreciated.

[1] Read before the Pathodontia Section, First District Dental Society of the State of New York, New York Academy of Medicine, February 17, 1930.

[2] Clinical oral surgery: *International Journal of Orthodontia, Oral Surgery, and Radiography*, 1928, xiv, p. 425 (May). Clinical oral surgery (Part Two): *Ibid.*, xiv, p. 795 (September).

Altogether, six cases will be reported: one of absorption at the neck of a root in a case of impaction; five others belonging to the group of neoplasms.

II. ABSORPTION AT THE NECK OF A ROOT IN A CASE OF IMPACTION

Male, age 26; September 11, 1929. *Chief complaint:* pain and throbbing sensation in left mandible for about a week. *Previous history:* a few months ago had slight pain on this side also, but it disappeared. *Extraoral examination:* negative. *Intraoral examination:* left mandibular third molar (⌊$\overline{8}$) partially erupted; surrounding soft tissues slightly swollen and inflamed. *X-ray examination:* see *figs. 1* and *2*. *Transillumination:* negative. *Pulp test:* left mandibular second molar (⌊$\overline{7}$) responds a little higher than right mandibular second molar ($\overline{7}$⌋), probably owing to pressure of malposed left mandibular third molar (⌊$\overline{8}$). Advise periodic pulp tests after operation.[3]

FIG. 1

FIG. 2

FIG. 1. ABSORPTION AT NECK OF ROOT OF SECOND MOLAR IN A CASE OF IMPACTION; INTRA-ORAL FILM

FIG. 2. ABSORPTION AT NECK OF ROOT OF SECOND MOLAR IN A CASE OF IMPACTION; EXTRA-ORAL FILM

Operation. On September 14, 1929, conductive and local infiltration anesthesia given on buccal side in region of left mandibular second and third molars (⌊$\overline{78}$). Incision made on buccal side of second molar (⌊$\overline{7}$) downward and forward; second one, over third molar (⌊$\overline{8}$) just posterior to second (⌊$\overline{7}$). Mucoperiosteal flap so outlined then elevated and held retracted, and enough bone chiseled away on buccal side of third molar, as

[3] All transilluminations and pulp tests were made by my associate, Dr. Herman L. Reiss.

well as posteriorly, to permit removal. On posterior side of second molar (|$\overline{7}$), just below neck, was large cavity leading most likely into root canal. Therefore, second molar (|$\overline{7}$) also removed. Bone then smoothed, and flap replaced after all debris removed, and held in position with three dermal sutures. *Discharged:* October 17, 1929.

As may be seen in the x-ray picture, the crown of the left mandibular third molar (|$\overline{8}$) was lying against the neck of the second molar (|$\overline{7}$), where a considerable loss of tooth structure was noticed.

FIG. 3. LEFT MANDIBULAR SECOND MOLAR SHOWING DEEP CONCAVITY AT NECK, ABSORPTION OF APICES, AND CHRONIC DEGENERATIVE CHANGES OF PULP

Macroscopic examination of the extracted teeth. The neck of the left mandibular second molar (|$\overline{7}$) showed a deep cavity; no discoloration, no debris of caries, no soft tissue could be made out. The surface seemed to be quite smooth. The left mandibular third molar (|$\overline{8}$) shows no macroscopic change. Sections were made through the two teeth (*figs. 3* and *6*). *Left mandibular second molar* (|$\overline{7}$): at the site of the cavity the dentine is very markedly absorbed. It became very thin, the pulp chamber in this region being covered only with a very thin layer of dentine. The pulp is very markedly atrophied, the odontoblastic layer is almost totally absent. In the pulp chamber, several pulp-stones are present showing globular ar-

rangements; some of them, continuous with the dentine, are of the so-called "Dentikel" type. In the pulp chamber, there is also an abscess filled with detritus near the absorbed wall. In the root canal, there are calcifications, some old abscesses filled with a necrotic mass and also new abscesses filled with pus cells, each surrounded by a capsule. The apices show absorption; in the lacunae, osteoclasts are embedded. The peridental membrane is thick, and contains a large number of inflammatory cells.

In a more thorough examination of the region of absorption, we notice first (*fig. 4*) that the dentinal tubules are quite intact; no bac-

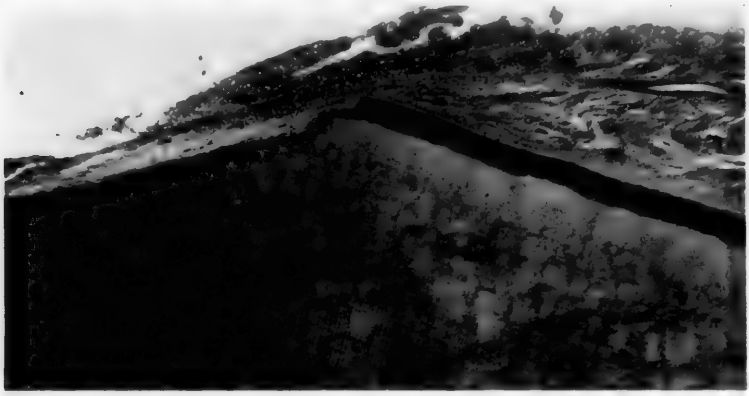


FIG. 4. HIGHER MAGNIFICATION OF PART OF *fig. 3*, SHOWING REGION OF CONCAVITY COVERED BY PERICEMENTAL CONNECTIVE TISSUE

terial invasion can be seen. Therefore, we are able to eliminate a carious origin for this excavation. The second possibility is that, owing to the pressure of the crown of the third molar, pressure atrophy took place, but we notice that the surrounding connective tissue can be followed into this excavation, and occasionally some osteoclasts are embedded in the lacunae. This fact proves that here not a passive pressure atrophy is present, but an active process of the connective tissue, which was pressed between the two teeth, this connective tissue forming the osteoclasts. What is the irritating factor? At the apices, the osteoclasts are also present in large numbers (*fig. 5*), but we also see the periapical round-cell infiltration in the peridental membrane

as a cause of their presence. Upward toward the neck, the cementum and pericementum are normal; no inflammation is seen. The osteoclasts appear again, but without any sign of inflammation in the region of the cavity. We must assume, therefore, that in this region the pressure of the crown irritates the connective tissue to the formation of osteoclasts. On the other hand, although malposed teeth very frequently show absorption, the *left mandibular third molar* ($\overline{8}$) does not show any absorption at all, and the remnants of normal enamel are

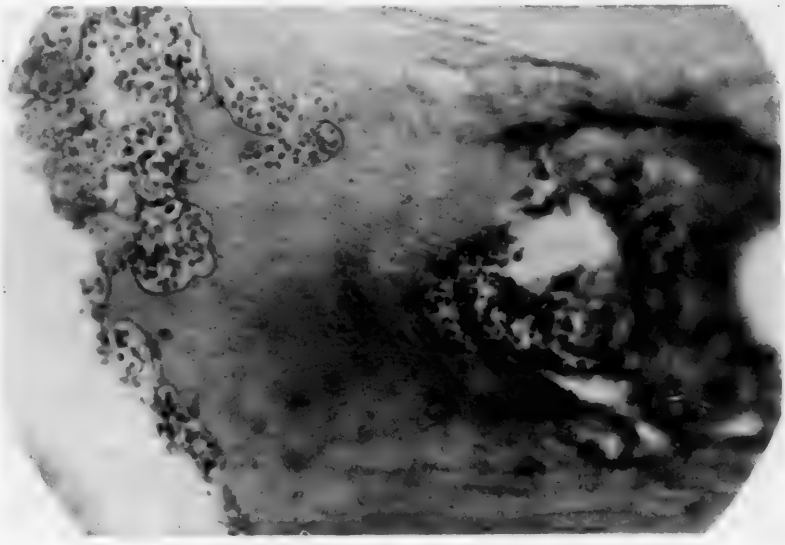


FIG. 5. HIGHER MAGNIFICATION OF PART OF *fig. 3*, SHOWING ABSORPTION AT APEX DUE TO OSTEOCLASTS

clearly visible at the crown (*fig. 6*). This is very interesting, considering the fact that, in the theories about the absorption processes of impacted malposed teeth, mechanical pressure always plays a very important rôle. Maybe absence of absorption in this case is due to intact capsule surrounding it, mostly the external ameloblastic layer, which functions partly as a protective membrane.

We have another similar case in which there is secondary-dentine formation, from the inside, to strengthen the very thin walls. Prob-

ably the vitality of this pulp was stronger than that in the case referred to above.

Clinically, one would assume that in the case of a partly erupted mandibular third molar, the second molar, if showing loss of tooth structure, would be decayed. The slower response to the electric current, as stated above, is explained here by the pathological changes in the pulp tissue. Pain in the second molar was due to changes in the pulp, in the chamber and canal as well as at the apical region. The importance of pulp-testing of the second molar in all these cases

FIG. 6. MALPOSED LEFT MANDIBULAR THIRD MOLAR WITH PART OF CAPSULE. NO ABSORPTION IN HARD SUBSTANCE

not only before, but also at intervals after operation, is quite evident. That a post-operative x-ray examination should be a routine measure, is no longer a matter of doubt. Any acute infection of the soft tissues or bone must be treated before the operation is undertaken.

III. HYPERCEMENTOSIS OR CEMENTOMA

Female, age 62. December 11, 1929. *Chief complaint:* patient has trouble with feet, and her physician wishes to eliminate mouth and teeth as possible sources of infection. Has occasional pains in feet when walking on street pavement; in house, they never bother her. *Past medical history:* has had neuralgic pains in different parts of body since girlhood. After complete x-ray examination (*figs.* 7 and *8*), pulp test revealed left mandib-

ular second premolar (⌊5̄) vital, and first molar (⌊6̄) negative; transillumination, negative. Patient advised to have all maxillary teeth removed; also left mandibular second premolar and first molar.

Operation. December 18, 1929: left mandibular; 2 cc. local infiltration buccally in region of left mandibular first and second premolars, and first molar (⌊4̄5̄6̄). Incision made on buccal side of second premolar (⌊5̄) downward and forward, approximately 1 cm. Free gingiva on buccal side of second premolar and first molar (⌊5̄6̄) separated from pericemental attachment, and mucoperiosteal flap so outlined elevated and held retracted. In apical region of first molar (⌊6̄), slight bony swelling about 1 cm. in diameter chiseled away; then irregular hard mass exposed. To weaken

FIG. 7 FIG. 8

FIG. 7. HYPERCEMENTOSIS OR CEMENTOMA; INTRA-ORAL FILM
FIG. 8. HYPERCEMENTOSIS OR CEMENTOMA; EXTRA-ORAL FILM

bone still more, whole outer plate in region of first molar (⌊6̄) chiseled away, and then tooth with hard apical enlargement removed in toto. Some additional soft and hard tissue was peeled out from this apical region, after second premolar (⌊5̄) had been extracted. Bone then smoothed, and all debris removed. In lower part of outer plate, mental branch visible and carefully avoided. Flap replaced and held in position with three dermal sutures. Argyrol.

Sections[4] were made through the left mandibular first molar (⌊6̄) and the attached tumor mass, and through the premolar (⌊5̄).

Microscopic examination shows (*fig. 9*) that the tumor mass is com-

[4] All pathological reports and comments were written by A. Furedi, M.D., Director of my Medical Laboratory.

posed of a very cellular fibrous tissue, in which numerous small bony plates, masses of cementum-like substance and occasionally characteristic "Zementikels," are embedded. Both roots show very marked hypercementosis, especially the anterior one, which seems to be embedded in a big mass of cementum. In the original cement layer of the roots, no previous absorption could be made out. The root canals from within are also lined with a layer of cementum. The

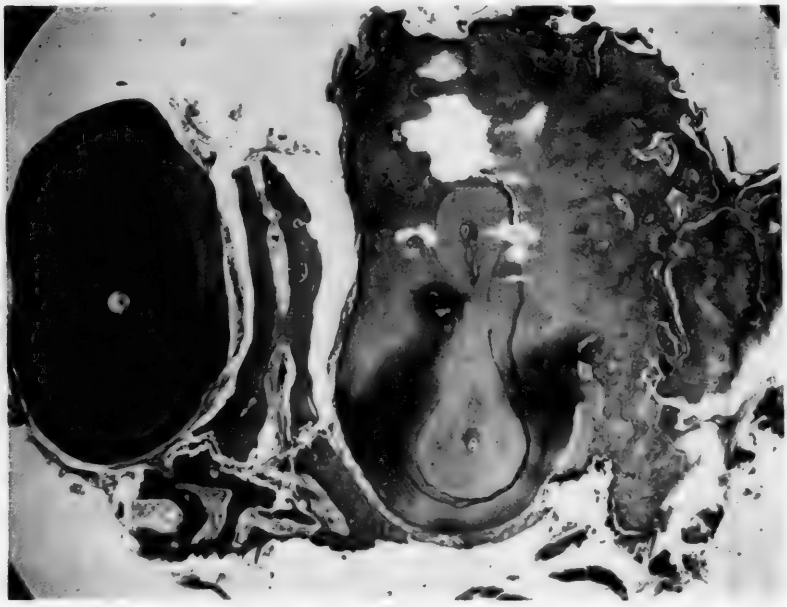


FIG. 9. CROSS-SECTION THROUGH LEFT MANDIBULAR FIRST MOLAR. ANTERIOR ROOT APPEARS TO BE EMBEDDED IN LARGE MASS OF CEMENTUM

pulp in the posterior root shows reticulated atrophy, while the odontoblastic layer is totally absent. The walls of the capillaries show hyalin-degeneration. In the anterior root the condition of the pulp is the same, but in one area some round-cell infiltration is present. The alveolar bone between the two roots is intact; at the side of the anterior root it is almost totally absorbed, but small fragments are still visible in an osteolytic stage. In this portion, the peridental membrane is replaced or converted into a very cellular fibrous stroma,

producing partly more cementum-like substance, partly rather well formed bony trabeculae, the latter being surrounded by osteoblasts and osteoclasts.

The second picture (*fig. 10*) shows the apex of the premolar ($\overline{|5}$) with the attached tumor mass. The very marked hypercementosis and invasion of the cementum into the root canal, the fibrous stroma of the tumor with bony plates, is almost the same.

FIG. 10. APEX OF LEFT MANDIBULAR PREMOLAR, WITH ATTACHED TUMOR MASS

Two questions arise: (a) what kind of pathologic process was present, inflammatory or neoplastic? (b) Where did it originate? The answers require consideration of many possibilities. Possibly there was an inflammatory process, due to chronic irritation in the peridental membrane of teeth either dead or undergoing chronic inflammatory changes, the so-called hypercementosis. The process involved not only the apical region of this molar, but also the premolar and the surrounding portion of the mandible. On the other hand,

we are not able to find inflammatory signs in the peridental membrane, nor any sign of resorption in the original cementum layer. The second possibility is a neoplasm, namely, osteoma, cementoma, osteofibroma, cementodontoma, which is really a partial odontoma with predominant development of cementum. (But the roots are fully developed; and, as we know, in a partial odontoma, attached to the roots, this portion of the tooth is not regularly developed. In spite of this fact, it is probable that at a later time, when the calcification would be more complete, we would diagnose it as a par-

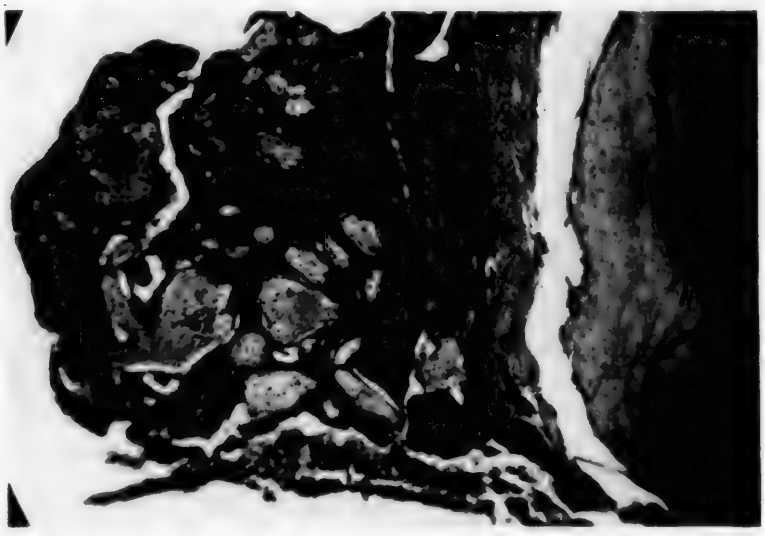


FIG. 11. HIGHER MAGNIFICATION OF PART OF *fig. 10*

tial odontoma.) It seems almost certain that the process originates from the peridental membrane. If we examine the separate portion of the tumor (*fig. 11*), we see the same picture as in osteitis fibrosa: cellular fibrous tissue, newly formed bony plates, osteoclasts, osteoblasts, etc. We may readily suppose, therefore, that an osteitis fibrosa is present here, originating from the peridental membrane.

Even a careful study of the roentgenogram makes a diagnosis practically impossible owing to the fact that not enough of these cases are seen by one operator. Aside from that, not even the pathological

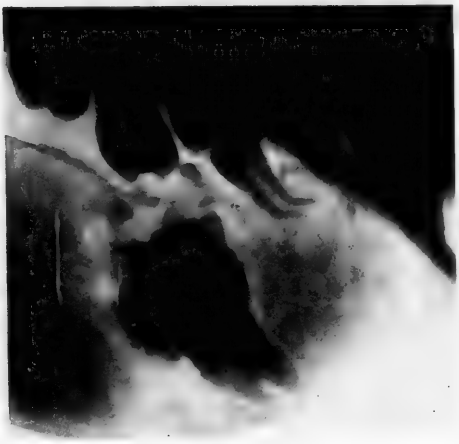
diagnosis is certain. Although this patient was under the author's care at intervals for the last twelve years, an opportunity was given only recently to x-ray the whole mouth and jaws, as I feel should be done in every case. Had this been done at the first visit, twelve years ago, the two teeth might have been saved. In the pulp test, the first molar did not respond at all, although its pulp showed living tissue. (Some nerve fibers partly necrotic; in another area, quite normal fibers are present.)

IV. ODONTOMA

Male, age 11. January 30, 1929. *Chief complaint:* swollen face, left side, no pain. *Past medical history:* swelling became evident five months ago. Some time before, patient had fall, and right maxillary central incisor (1|) broken. *Pulp test:* right maxillary central incisor (1|) responds slightly, indicating tooth only partially vital. Pulp should be removed. Left mandibular canine, and first and second premolars (|345), also respond only slightly, indicating pathological condition this region had some effect on pulps. *Extraoral examination:* enlargements of left side of face in region of mandible, beginning about 2 cm. from median line back to angles, causing more or less marked distension. In palpating, swelling hard. Skin and subcutaneous tissues normal in appearance, and freely movable over mass. Inferior border of horizontal ramus of left mandible from mental region to angle feels much broader than right side. *Intraoral examination:* left mandibular central and lateral incisors, canine, and second premolar (|1235) in position; first premolar (|4) partially erupted. On mucous tissue over ridge, posterior to second premolar (|5) can be seen cusp marks of left maxillary second premolar and first molar (|56). Entire body of mandible, posterior to left mandibular first premolar (|4), enlarged and irregular, uneven, and hard to palpation. Overlying mucous tissues freely movable. *X-ray examination:* see *figs. 12, 13,* and *14.*

Operation. October 29, 1929: at hospital, under ether anesthesia, incision made on buccal side of left mandibular canine (|3), downward and forward approximately 1.5 cm.; second one, along ridge posterior to second premolar this side (|5), running all the way up along lower part of ascending ramus. Mucoperiosteal flap elevated and held retracted. Left mandibular canine, and first and second premolars, (|345) extracted; then outer plate of bone, beginning in region of canine (|3), chiseled away up to middle of this large tumor mass. Tumor in this region seemed soft, and could easily be removed with large curet until smooth, apparently healthy, bone encoun-

tered. However, no decided difference existed between tumor and surrounding bone, as found later in part of tumor posterior to hard odontoma. Chiseled out, was about same size as seen on x-ray. With it came a molar tooth, apparently first molar ($\lfloor\overline{6}$), and a number of tooth germs. Posterior part of tumor now treated same as anterior, but after remov-



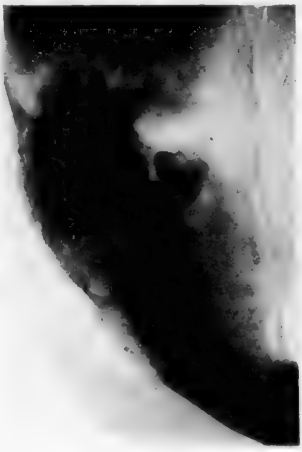


FIG. 12 FIG. 13

FIG. 12. ODONTOMA OF LEFT MANDIBLE; EXTRA-ORAL FILM
FIG. 13. ODONTOMA OF LEFT MANDIBLE; EXTRA-ORAL BITE FILM

FIG. 14. ODONTOMA OF LEFT MANDIBLE; INTRA-ORAL FILMS

ing center, was readily peeled out. Outer layer dense and cartilaginous. Tumor extended up, and very close, to sigmoid notch, and had widely separated inner and outer plates of ascending ramus. As last step, mucous and submucous tissue along region of molars on this side ($\lfloor\overline{678}$) removed, and with it number of tooth germs. Inferior dental structures seen, at lower and outer part of bony shell, covered by bony ridge. It left this ridge

in outer part of cavity more anteriorly, where it could be seen to enter lower lip as mental nerve. Outer flap folded in, and held in this position with two pieces of iodoform gauze. Buccal incision in region of canine ($\overline{|3}$) closed with one catgut suture. Argyrol.

Treatments: at hospital until November 2, 1929. At office thereafter. *Re-examination:* November 10, 1929—x-rays, blood and urinalysis. December 21, 1929—x-rays (*fig. 15*). Patient still under observation.

Sections of different portions of this tumor mass were made; the first, through the soft tissue surrounding almost the whole mass, as a

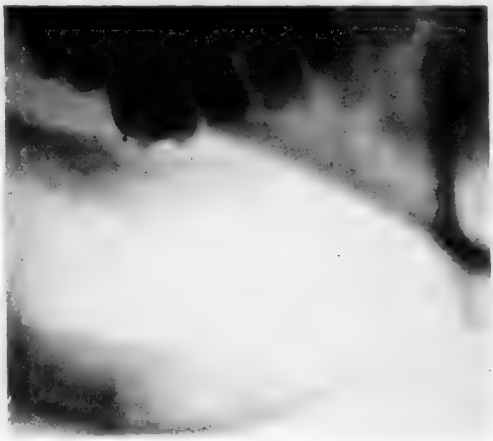


FIG. 15. ODONTOMA OF LEFT MANDIBLE; POST-OPERATIVE EXTRA-ORAL FILM

capsule-lining from within the bony cavity in the mandible. The *microscopic examination* shows that this capsule is composed of fibrous tissue, which in some parts is very cellular. Embedded in the cellular stroma, small bony plates are seen occasionally, giving the impression of newly formed bone surrounded by a dense layer of osteoblasts. The other sections reveal that the chief feature of the tumor is the presence of all the various structures normally contained in a tooth. Dentine, enamel, cementum, and pulp tissue are in varying proportion; and, as a ground substance, a very cellular connective tissue is seen. The hard substances are in part fully developed and regular; in part, irregular, not calcified. Numerous tooth-like formations can be

made out, composed of dentine and enamel (owing to the decalcification, only the empty spaces are visible); some of them contain pulp-like tissue. They are usually connected by cementum.

This microscopic picture is very characteristic of the so-called odontoma, by which we mean a tumor originating from the dental follicle, arising from the structures that normally originate the tooth, and containing both enamel organ and papilla. Although in our sections only a very small number of ameloblasts could be made out,

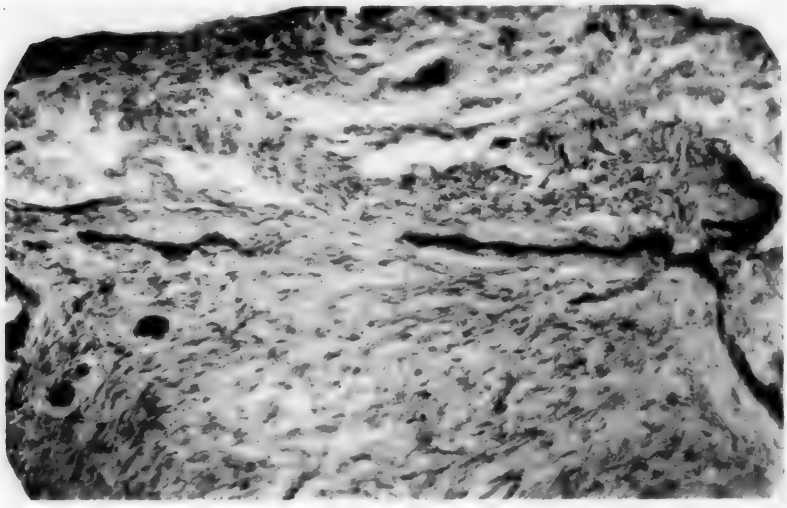


FIG. 16. "ANLAGE"-LIKE PROCESSES OF EPITHELIAL CELLS EMBEDDED IN DENSE CONNECTIVE-TISSUE STROMA

we have to suppose that in the early stages of the development large amounts of epithelial structures were present. (In the early stage, the picture would be composed of proliferated epithelium with long processes, islands of epithelial cells, ameloblasts, and actively growing connective-tissue stroma.) In *fig. 16* we see the dense fibrous tissue in which are present processes and islands of undifferentiated ameloblasts. Some of these processes show the characteristic picture of the follicle in its earliest stage, as the surrounding connective tissue forms the papilla. [These processes and islands are surrounded by a

somewhat homogeneous layer, in which swollen connective-tissue fibres are embedded (in case the connective tissue is not dentine-forming). This homogeneous mass is a product of the epithelial cells, probably an abortive enamel-formation.] Later (*fig. 17*), the ameloblasts will produce the normal regular enamel; the papilla, regular dentine; and then we see the tooth-like formations; some of them contain also pulp tissue.

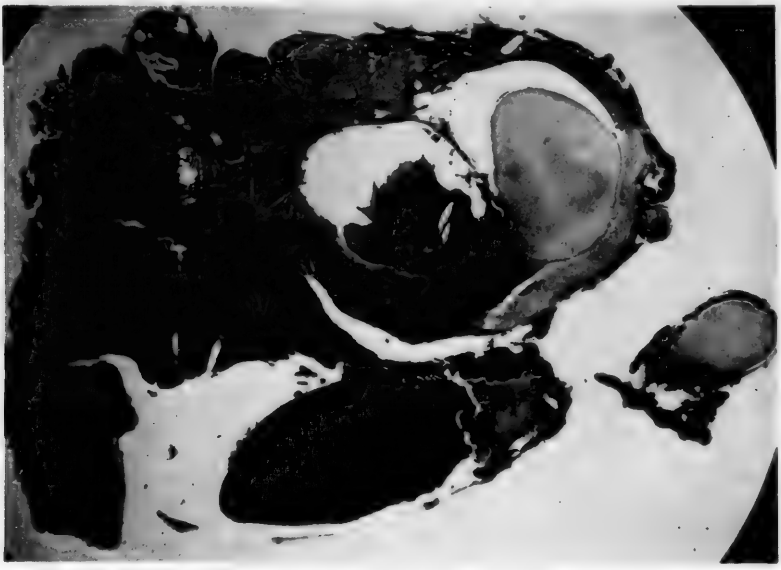


FIG. 17. SMALL TOOTH-LIKE FORMATIONS

There are places where, embedded in a large mass of dentine, denticles and small enamel-islands are seen, mostly irregular enamel (*fig. 18*). As we saw in the case where ameloblasts were either embedded in or surrounding special dentine-forming connective tissue, they will be able to produce either quite regular or irregular, but distinct, enamel substance. In another part, we see small epithelial islands embedded in connective tissue; and also in the neighborhood, cementum, showing that this connective tissue is cementum-forming (*fig. 19*). Here we see how these ameloblasts change into globules of

calcium ("Kalkkugeln"), and then irritate the encircling connective tissue to form surrounding hard substance ("Zementikels"). The same globules are found very often in the peridental membrane of the normal tooth, where we believe they originate from the remnants of Hertwig's sheet. From this fact we are able to confirm Weber's and Gottlieb's opinion, namely, that ameloblasts are able to produce

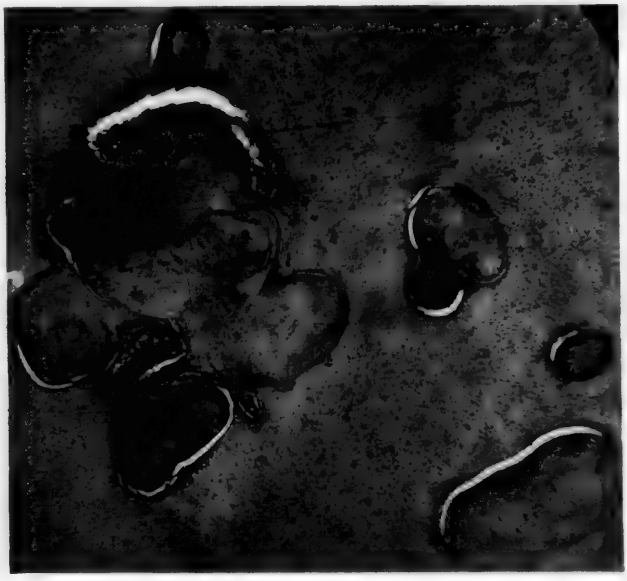


FIG. 18. SEVERAL DENTICLE-LIKE GLOBULES EMBEDDED IN REGULAR DENTIN

enamel only in the presence of dentine-forming connective-tissue cells.

As we have seen, the different portions of the tumor are in different stages of development. Portions are composed almost exclusively of hard substances; in other portions, soft tissues predominate. In accordance with the predominance of soft or hard substances, we call them soft or hard odontomas. Usually the former evolves into the latter.

The case of this boy is exceptional from every standpoint. The

x-ray is extremely instructive. The fact that he was operated on under ether, without fracture and apparently with complete removal, is more than fortunate, considering the large mass and the very thin quality of the bone shell (*fig. 15*). However, he will have to be kept

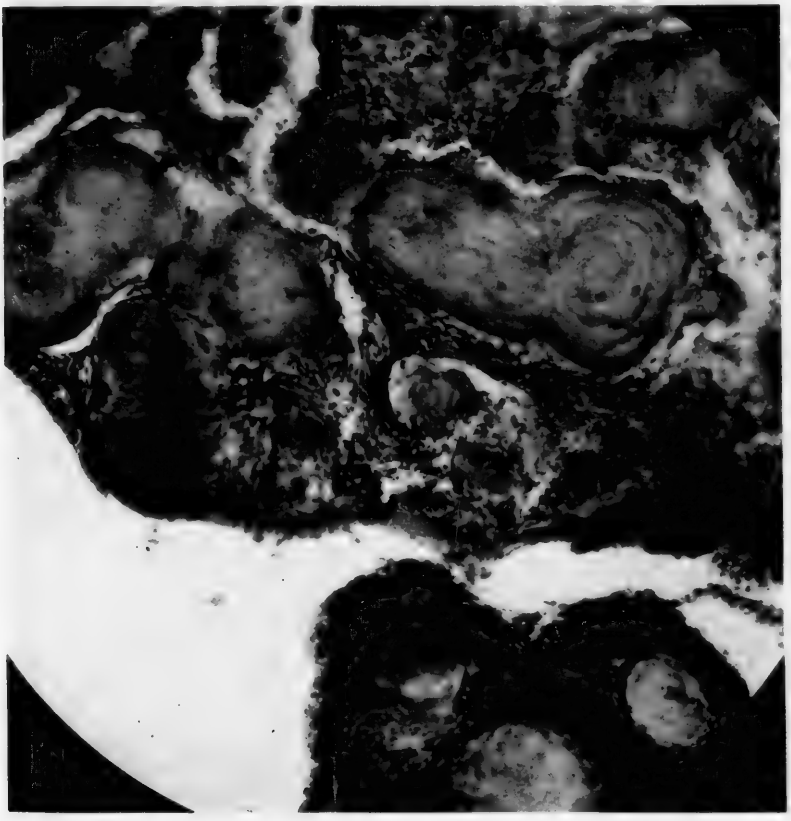


FIG. 19. CEMENTICLES AND GLOBULES OF CALCIUM ("KALKKUGELN")

under further observation, especially by means of the x-ray, to determine whether any tumor structure has been left, which later would, on account of its calcification, be more easily detected.

In my experience, simple odontomas have been found mainly in the mandible, only once in the maxilla.

V. GIANT-CELL TUMOR

Male, age 8. November 29, 1929. *Chief complaint:* swelling in mandible between central incisors. ($\overline{1|1}$). No pain. *Extraoral examination:* negative. *Intraoral examination:* on labial side, between mandibular central incisors ($\overline{1|1}$), is soft slightly movable mass about 1 cm. in diameter, and protruding about 2 mm. from surrounding surface. Upper half purplish-red; lower half, pink. Lingual surface slightly distended between central incisors ($\overline{1|1}$); upon palpation, crepitus. Mass causes separation of these two teeth. Mandibular central and lateral incisors in position ($\overline{21|12}$). Salivary secretions moderate. *Past medical history:* negative. Attention directed to swelling only few months ago. *Transillumination:*

FIG. 20

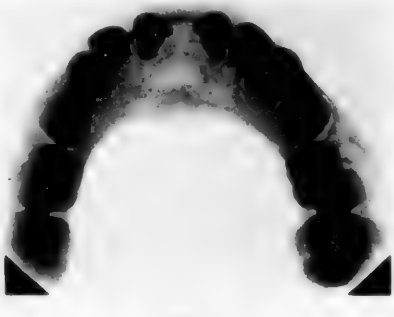


FIG. 21

FIG. 20. GIANT-CELL TUMOR OF MANDIBLE; INTRA-ORAL FILM
FIG. 21. GIANT-CELL TUMOR OF MANDIBLE; EXTRA-ORAL FILM

marked circumscribed shadow about 1 cm. in diameter, in region of labial soft tissues of central incisors ($\overline{1|1}$). *Pulp test:* mandibular central incisors ($\overline{1|1}$) respond to a lower index, probably owing to pressure of tumor mass. *Recommendations:* x-rays (*figs. 20* and *21*), pulp test, transillumination, blood examination, and urinalysis.

Operation. Local circumscribed infiltration on labial and lingual sides in region of four incisors ($\overline{21|12}$). Incision made on labial side circumscribing tumor, upper extremities of this circle reaching free gingiva at $\overline{1|1}$ close to right mandibular lateral incisor ($\overline{2|}$). Incision carried down to bone, and central incisors loosened. Incision made on lingual side, just between ridge formed between separated central incisors ($\overline{|11}$); then whole mass, including $\overline{1|1}$, was peeled out and removed. Prominent parts of bony ridges smoothed with bone forceps and curet, three dermal sutures inserted, and

argyrol and iodoform gauze placed in wound. During operation bony plate on lingual side, over area of nearly 1 cm. in diameter, very much thinned out and removed. Patient still under observation.

Sections were made through the tumor mass itself, and through one of the lower incisors with the attached tumor mass. *Microscopic examination* reveals the tumor mass to be composed essentially of giant cells, mostly of large size and containing very numerous separate

FIG. 22. LOWER INCISOR, WITH ATTACHED TUMOR MASS

nuclei. Towards the periphery, they are reduced to scanty numbers and the spindle-cell stroma is much more predominant, but pleomorphism of the cells of the stroma is absent. The central areas are free from traces of bone formation. Some small remnants of alveolar bone are seen in the stage of osteolysis; but towards the periphery, and in the capsule of the tumor, rather active bone formation, as well as destruction of the bone-shell by the giant cells from within, and the apposition of new bone by dense rows of osteoblasts from without, are seen, giving the characteristic picture on the x-ray. The tumor is rather vascular, and numerous areas of hemorrhage are seen.

Very interesting is the behavior of the teeth as seen on the x-ray (*fig. 20*); their roots are curved to surround the tumor. We see that, microscopically (*fig. 22*), the tooth is not yet fully developed. On the side towards the tumor, the alveolar bone is in a stage of osteolysis. The peridental membrane lost its characteristic arrangement, and was converted into very cellular spindle-cell tissue, which can be followed into the tumor stroma. Only at the apex is the arrangement of the peridental membrane again normal. The pulp is normal; but, in the lower portion of the root canal, a large hemorrhagic area is visible—also at the apex, which is in the developmental stage. From this fact, we have to suppose that the tumor was there before these curved portions of the roots developed; in other words, the growth of the tumor influenced the root formation. However, if the force of the growing tumor had shared in this formation by means of pressure, absorption in the hard substance would have occurred.

The real nature of this tumor is not yet known: it may be a neoplasm, or a reactive proliferative process due to an antecedent intramedullary hemorrhage. It is also questionable whether the different varieties of lesions in which this kind of giant-cell mass appears, namely, the giant cell observed in the growth of osteitis fibrosa cystica, giant-cell epulis, and the central giant-cell tumor, are the same. In accordance with most opinions accepted at present, the first stage is the osteitis fibrosa cystica, in which the red marrow is replaced by cellular fibrous tissue. Owing to trauma, usually found in the histories, an intermedullary hemorrhage occurs, which may be followed either by retrogressive changes leading to bone cyst, or to progressive changes giving rise to giant-cell tumors.

Etiology. The cause of tumors is unknown: some exciting conditions are mechanical irritation, caries, plates, bridgework, disturbance in the eruption of the teeth. The histologic structure is very important for the clinical course and prognosis. Giant-cell tumor, composed essentially of giant cells, is benign. With a very notable proportion of spindle cells, the tumor may be benign, if no pleomorphism is present, but the prognosis is less certain in regard to recurrence. With advancing age of the patient and variations in the structure of the tumor, there is always the possibility that certain features of malignancy will appear. The prognosis is less favorable with each

recurrence. Rapidity of growth is a sign of aggressiveness, as is also the destruction of a large portion of the bone-shell surrounding the tumor.

Here the case was clinically diagnosed by oral examination and study of the x-ray. The removal of the adjacent teeth was very essential, because of the supposed origin of the tumor from the peridental membrane or periosteum. Although these tumors occur mainly in the young, we recently had a case of giant-cell tumor in a woman 53 years of age.

VI. OSTEOGENIC SARCOMA

Male, age 30. March 8, 1926. *Chief complaint:* swelling in right maxilla; seems to be increasing in size last four weeks. *Extraoral examination:* negative; submaxillary glands slightly enlarged on both sides. *Intraoral examination:* in right maxilla, beginning in region of first premolar ($\underline{4}|$) and extending to posterior aspect of maxilla—on palatal side practically to median line, and on buccal side to about 1.5 cm. above ridge—mass over 3 cm. in diameter, covered by smooth mucous membrane. Surface of hard mass irregular and uneven on palatal side, similar on buccal side, ending abruptly at point mentioned before. Teeth in this region: right maxillary second premolar and third molar ($\underline{5}|$, $\underline{8}|$); premolar firm, while third molar slightly loose. In between, open wound, showing evidence of recent operation. Wound 1 cm. postero-anterior, little over 1.5 cm. from side to side, and approximately 1.5 cm. deep. Some slight granulations, and grayish covering membrane. *X-ray examination:* see *figs. 23* and *24*.

Operation. April 17, 1926: removal of tumor in right maxilla, at hospital. Right tuberosity and anterior palatine, right infraorbital, and local infiltration buccally above fold. Attempt made to remove right maxillary canine ($\underline{3}|$) with forceps, but not successful. Incision then on labial side at right maxillary lateral incisor ($\underline{2}|$) upward and forward, and enough of buccal plate chiseled away to permit removal of canine ($\underline{3}|$) with forceps. Another incision then made above fold, through soft tissues to periosteum forward to canine ($\underline{3}|$), and same retracted. Incision made on palatal side, circumscribing tumor mass well outside periphery of tumor; and then bone was chiseled through, above tumor on buccal side, from canine back to posterior aspect of maxilla, and on palatal side well outside tumor mass. Tumor finally removed by severing soft tissue posterior to tumor mass. Soft tissues of nasal floor exposed and perforated only at one point, approximately 1 cm. in length. Posteriorly soft tissues brought together as well as

possible with three black-silk sutures. Remaining wound packed with iodoform gauze.

Pathological report. Macroscopic examination.—Specimen consists of irregularly shaped piece of tissue measuring 4.8 cm. by 4.5 cm. by 3.2 cm. Part of surface covered by mucous membrane. From this surface several teeth project. On cross-sectioning, tissue found to consist of soft cancellous bone. *Microscopic examination.*—Sections of soft tissue show well formed

FIG. 23 FIG. 24

FIG. 23. OSTEOGENIC SARCOMA; EXTRA-ORAL FILM
FIG. 24. OSTEOGENIC SARCOMA; INTRA-ORAL FILM

surface-epithelium, from basilar layer of which thin strands of well formed epithelial cells project into underlying connective tissue. Latter densely infiltrated with round cells, a few plasma cells, and fibroblastic tissue. Sections of bony tissue show spicules of bone surrounded by numerous osteoclasts. Soft tissue in bone composed largely of cellular connective or fibroblastic tissue, containing varying amount of round-cell and some polynuclear infiltration. Several small areas of calcium-deposit also present. No histological evidence of malignancy. *Diagnosis:* chronic productive inflammation.

Treatments: daily until April 10, when discharged from hospital. Then treated at office; dismissed, October 1926.

Re-examination: September 1927, x-rays. February 1928, x-rays. August 1928, negative. May 1929, stereoscopic plates. December 1929, x-rays (*figs. 25* and *26*); impressions, January 1930.

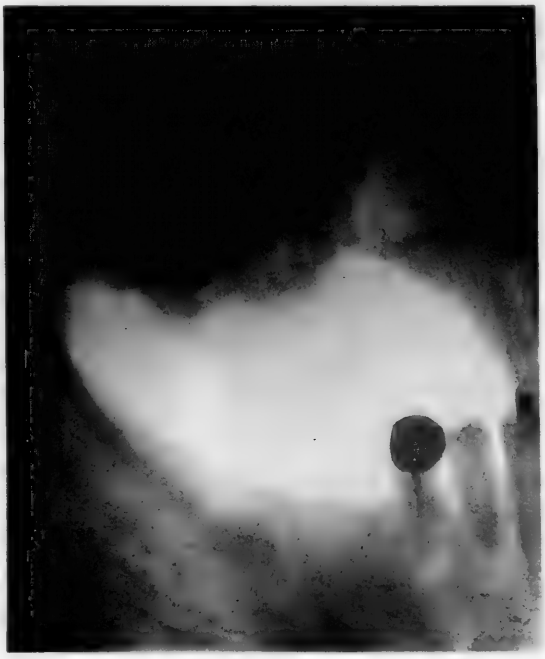


FIG. 25. RECURRENCE THREE YEARS AFTER OPERATION; EXTRA-ORAL FILM

New chief complaint: pain under mastication only in right maxillary region. Right side of nose stuffed; bleeding through left nostril about every week and a half for day or two. *Extraoral examination:* right side of face slightly more distended than left. Skin normal in appearance and to palpation. *Intraoral examination:* posterior two-thirds of hard palate on right side elevated about 1 cm. as compared with surface on left. Elevation resembles triangle in outline, with base at median line of palate and apex at malar process of maxilla. Hard to palpation. Mass causes distension, buccal fold being entirely obliterated on right side. Salivary secretion of

right parotid seems a little less than of left. *Recommendations:* x-rays, stereoscopic plates, blood examination, and urinalysis.

Sections were made (January 1930) through different portions of the tumor mass. *Microscopic examination* of a cross-section through the tumor mass, with embedded apex (*fig. 27*), shows that the chief feature of the tumor is the presence of immature and atypical bone, cartilage

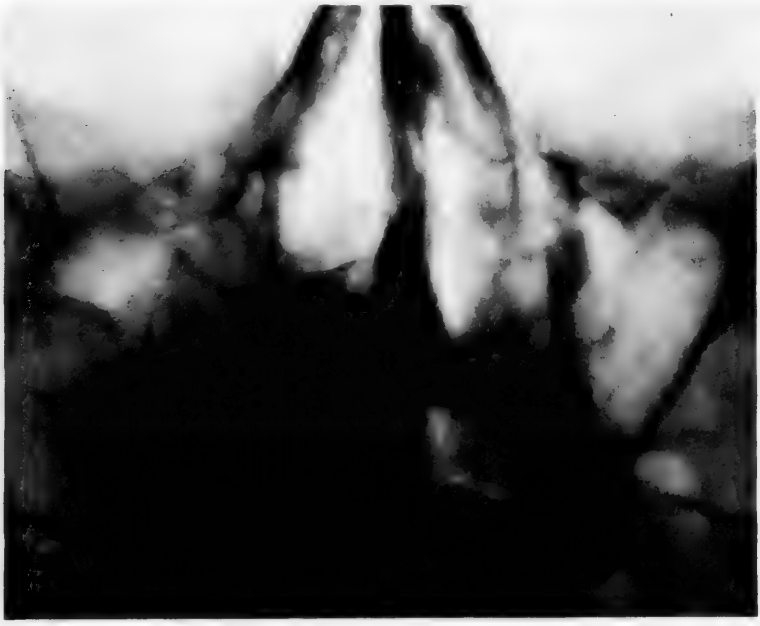


FIG. 26. RECURRENCE THREE YEARS AFTER OPERATION. ANTRUM VIEW OF RECURRENCE. LEFT ANTRUM NORMAL

and osteoid tissue, and pleomorphic tumor-cells. The cells are mostly rounded and polyhedral; in some areas, hyperchromatic spindle type. The intercellular material is partly reduced to hyalin; in part it appears as islands of immature cartilage or as trabeculae of bone. Only in small areas is seen a dense hyperchromatic spindle-cell stroma, which is more vascular. The cross-section of the apex shows (*fig. 28*) a very marked absorption in the portion towards the tumor mass,

where the alveolar bone is entirely absent and the peridental membrane almost totally involved in the tumor process. The portion surrounded by normal alveolar bone does not show any absorption, but a slight hypercementosis. Interesting is the fact that in the

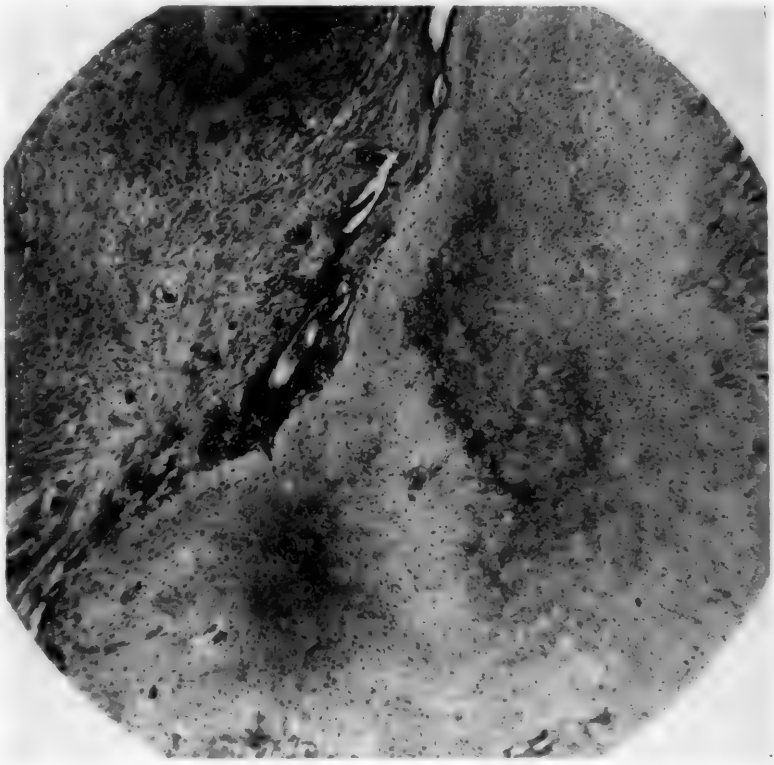


FIG. 27. OSTEOGENIC SARCOMA. ISLANDS OF ATYPICAL CARTILAGE, SHOWING CALCIFICATION

absorbed portion a very marked secondary cementum apposition is visible, which can be explained by the fact that the growth of the tumors is usually not continuous. There are intervals when the growth stops. Probably such a resting period made it possible for the tooth to form the secondary cementum as a repair. The pulp is necrotic, only a very small atrophied portion being visible.

The microscopic picture is very characteristic of osteogenic sarcoma, a tumor which primarily occurs in bone arising from bone cells or osteogenic tissue. If it occurs in the region of teeth, it may cause different changes. Usually a very marked absorption takes place, because a sarcomatous tumor has connective-tissue ground-substance, which performs the absorption; it also can loosen the teeth or displace them. The etiology is highly obscure. An occasional trauma may be an exciting factor, although many tumors arise in bones

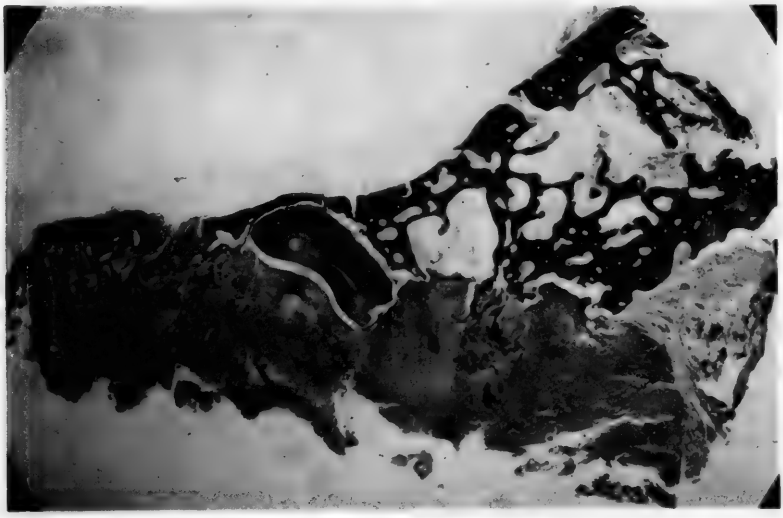


FIG. 28. CROSS-SECTION THROUGH TUMOR MASS, CONTAINING APEX OF MOLAR TOOTH TUMOR MASS CLEARLY BORDERS ON NORMAL SPONGIOSA

protected from injury, and usually the tumor precedes the trauma. Theories include disorder in the growth of bone, displacement of islands of cartilage, and certain general constitutional factors. The clinical course, which varies greatly, is generally in accordance with the histological structure, greater malignancy being associated with more cellular or vascular character. With increase in the cellularity, one notices clinically an acceleration of growth of the tumor. As for the prognosis, there are also other very important factors, namely age, duration of the disease, location, etc. Under twenty years, the

patient's resistance is poor. Usually tumors that grow rapidly are nearly always malignant (encapsulation restrains growth, but after perforation it is rapid).

In our case, the growth tendency is moderate. The histological structure shows only moderate cellularity. Usually the most interesting cases are the most unfortunate so far as the patients are concerned. The pathological report for this patient, after the first operation, showed "chronic productive inflammation." When he returned to the office a few years later with additional complaints, it was thought best to examine the old specimen again and to prepare new sections, with the result that a definite diagnosis of osteogenic sarcoma was made. The patient will have to be operated on again. The prognosis is unfavorable, in spite of the fact that he is taken care of by a surgeon who combines radiotherapy with surgery.

VII. EPIDERMOID CARCINOMA; ADENOIDCYSTIC TYPE

Female, age 59. May 26, 1928. *Chief complaint:* slight soreness on roof of mouth. *Extraoral examination:* negative. *Intraoral examination:* superior labial frenum slightly inflamed. Mucous tissue covering posterior part of hard palate, to left of median line and within 0.5 cm. from alveolar ridge (total area of approximately 1.5 cm. in diameter), reddish blue and soft to palpation. *Past medical history:* patient believes soreness commenced by her pushing plate up hard, as it was quite loose. This began about six or seven weeks ago; has been using hot glyco-thymolin. *X-ray examination:* negative.

Operation. July 18, 1928: circumscribed local infiltration. Incision then made surrounding tumor well in sound tissues. Carried straight down to bone, and tumor itself, apparently with periosteum attached, removed. Anterior palatine structures ligated to prevent postoperative hemorrhage from this source. Argyrol, iodoform gauze.

Pathological report. Examination of sections (*fig. 29*) shows epidermoid carcinoma, which probably originated in ducts of mucus glands. Superficial epithelium everywhere intact, and tumor has none of features of squamous carcinoma. Some adenoid arrangement such as found in adenoidcystic epithelioma. Growth is fully malignant but not diffuse. *Diagnosis:* epidermoid carcinoma, adenoidcystic type. Prognosis fair as compared with squamous carcinoma. These tumors tend to recur locally, and occasionally metastasize. Problem in this case is to deliver dose of radiation

sufficient to destroy remnants of tumor cells, and at same time avoid bone necrosis. Patient receiving today 300 mchrs. of radium emanation, with platinum bulb applied directly to operative site. (July 28, 1928.)

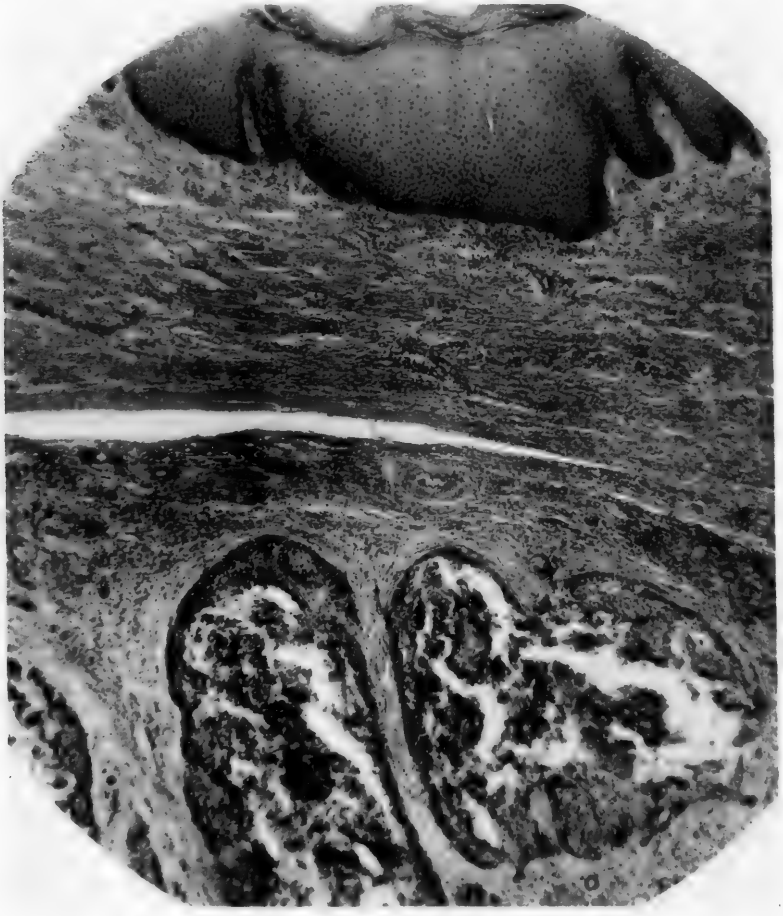


FIG. 29. CROSS-SECTION OF EPIDERMOID CARCINOMA; ADENOIDCYSTIC TYPE

Treatments: at intervals until February 1929. *Recurrence of tumor:* October 1929. *Treatments:* November 1929, radium. *Examination:* January 1930, "O.K." Still under observation.

This tumor might have been started through irritation by an artificial denture, and continued later by the application of a hot medicated solution. On account of the small size and well circumscribed nature of the mass, it was thought best to remove it, and to conduct the further treatment in accordance with the pathologist's diagnosis.

Swellings in this region must be differentiated from periosteal abscesses, mucous cysts, and angioendotheliomas. Histologically, the adenoidcystic type of carcinoma is at times difficult to differentiate from the adamantinoma. In fact, a case which I operated upon about ten years ago for epidermoid carcinoma (basal-cell type), and of which I was very proud, considering it a cured case, has now been diagnosed as adamantinoma.

It seems to me that this report, though only of six cases, presents convincing evidence that much more can be gained by the co-operative examination, treatment, and study of a large number of oral surgical cases than by an attempt to resect jaws for inoperable cases. First of all, routine examination of practically every case should include a complete intra- and extra-oral x-ray examination, pulp test, and transillumination. A great number of cases should have blood examinations (including bleeding time and coagulation), and urinalyses. All pathological specimens should not only be examined, but slides as well as the specimen preserved. The importance of keeping specimens is very clearly seen in the above described case of osteogenic sarcoma.

In conclusion, I again wish to emphasize my belief that the establishment of many laboratories for the sole purpose of studying pathological conditions of the mouth, in close co-operation with oral surgeons, would rapidly increase our knowledge very much. Especially would I like to emphasize my conviction that the oral cavity, on account of its accessibility, is a very fruitful field for the study of new growths in their incipiency, the results of which would be far-reaching.

101 East 79th Street

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Scientific Proceedings of the Eighth General Meeting[1]

Royal York Hotel, Toronto, Ontario, Canada
March 24–26, 1930

Compiled by WILLIAM J. GIES, F.A.C.D., *Secretary*[2]

Columbia University, New York City

CONTENTS

I. President's address 368
II. Paper transferred to a coördinated session of the American Association of Dental Schools: Morning, March 24; abstract 1 372
III. First session: Evening, March 24; abstracts 2–10 374
IV. Papers transferred to a coördinated session of the American Association of Dental Schools: Afternoon, March 25; abstracts 11–13 382
V. Second session: Evening, March 25; President's address (14), and annual executive proceedings 385
VI. Third session: Afternoon, March 26; abstracts 15–22 385
VII. Fourth session: Evening, March 26; abstracts 23–30 395
VIII. Papers read by title: abstracts 31–51 402
IX. Papers read by title: abstracts not available (52–54) 419
X. Titles of papers transferred to the program of a special meeting of the New York Section 420
XI. Data of executive proceedings 420

---

[1] The sessions of the Research Association were coördinated, by agreement, with those of the Seventh Annual Meeting of the American Association of Dental Schools. The members of each body were welcome at, and participated in, all the sessions of both associations. In the absence of the President, Dr. Arthur D. Black, Dental School, Northwestern University, who was en route to Japan, the chairmen were the Vice-president, Dr. A. E. Webster, Dental School, University of Toronto, and the President-elect, Dr. U. G. Rickert, Dental School, University of Michigan. Informal dinners were served to members and guests on the evenings of March 24 and 26. An account of the executive proceedings will be published in the supplement of this volume, in the number for December, 1930. Abstracts of the papers presented at the general meeting in 1929 were published in the *Journal of Dental Research*, 1929, ix, p. 269; June.

[2] Most of the abstracts have been prepared by those who presented the corresponding papers. All revisions have been verified by the authors.

I. President's Address[1]

A DENTAL RESEARCH PROGRAM

Arthur D. Black, A.M., M.D., D.D.S., Sc.D., F.A.C.D., Dental School, Northwestern University, Chicago, Ill.

Several years ago, the Chairman of the Chemistry Division of the National Research Council discussed with the writer certain principles which should, in his judgment, govern a research program. In doing so, he referred to a grant of $500,000 which had been allotted to various research groups in the petroleum industry, over a period of five years. Grants had been made in varying amounts to a large number of workers, with the result that much scattering research had been promoted, and, as the end of the five years drew near, it was realized that very little had been learned that could be practically applied. He expressed the opinion that it would have been better to request each research group to endeavor to solve the problem of removing sulphur from gasoline, because he felt that to be the most important practical question in the petroleum field of research, and real progress would probably have been made toward its solution. In other words, he emphasized the importance of concentration of research effort.

Two years ago a request was made on behalf of the Research Commission of the American Dental Association that a Dental Research Advisory Committee be appointed by the Executive Board of the Medical Division of the National Research Council. The Committee consisted of Prof. L. B. Mendel, of Yale; Col. Charles F. Craig, of the Army Medical School; Dr. E. R. LeCount, of Rush Medical College; Dr. Vilray P. Blair, of Washington University; and the writer, who was a member by virtue of the fact that he represented the American Dental Association in the National Research Council.

A year ago, the applications to the Research Commission of the American Dental Association, for grants, were referred to this Committee. Each application consisted of (1) a review of the literature on the problem, (2) its present status, (3) the proposed research, (4) the facilities at hand and the anticipated cost, (5) available consul-

[1] Read at the opening of the second session, preceding the annual business meeting. See page 385.

tants and advisors, and (6) information regarding each person to be a part of the research group. After a careful study of all this material, and a thorough discussion that occupied the greater part of a day, the Committee made the following report, which is considered of sufficient importance to be presented in full (excepting the list of grants that were approved):

"The Committee on Dental Research met on Wednesday, April 24, and reviewed a number of applications for grants referred to it by the Research Committee of the American Dental Association. Also, at the request of representatives of the American Dental Association, the general plans upon which grants have been made were discussed and certain recommendations were made relative to the direction of its research program.

"The Committee desires to express its appreciation of the attitude of the membership of the American Dental Association in supporting research, also of the efforts of the Research Committee in its encouragement of investigations by individual workers, as well as by those connected with the Dental Departments of a number of universities.

"It is clearly recognized that there are many problems within the dental field that are of importance to health, and that the time is opportune for a more extended program, which should receive the financial support of persons of means and the hearty coöperation of the medical profession.

"The following recommendations are made to the Research Committee of the American Dental Association:

"1. That a survey should be made of the problems suggested for study and that stress should be placed upon those of greatest importance, rather than to scatter grants among a large number.

"2. That more satisfactory results are likely to be obtained if grants are voted to men of known ability, rather than to projects.

"3. That it is fundamental to the successful study of many problems in this field that more extensive use be made of animals for experimental work.

"4. That careful inquiry be made to find those animals best suited to the work to be undertaken. This appears to be an exceptionally difficult problem in the study of dental caries."

More recently, the writer, as a member of the National Research Council, was requested to act as chairman of a committee to prepare a program which would portray the scientific achievements in dentistry during the past one hundred years, for the Century of Progress Exposition to be held in Chicago in 1933. This has necessitated a review of dentistry's research from the organization of the profession to date.

It is intended to make the contributions of science the central feature of the Chicago Fair. The plan involves demonstrations that will be of interest to the general public along two related lines: contributions of pure science, and applications of scientific discoveries. It was therefore necessary, in laying out a program for dentistry, to analyse as far as possible the progress of dentistry in connection with discoveries in related fields. This has been divided into three main sections: (1) the relation to biology and the medical sciences; (2) the relation to physics, chemistry, and metallurgy; (3) the relation to anthropology, paleontology, comparative anatomy, and comparative pathology.

These contacts have led the writer to propose that it might be worth while for this organization to make a survey of the dental field, and develop a program which would serve as a guide for men of inquiring mind who are inclined to devote part or all of their time to research. It is suggested that much more of real value might result, if there were reasonable direction of the trend of investigations. This suggestion is made with full recognition of the fact that research can not be charted in advance. However, for the most part an investigator undertakes to find the answer to a question, and there should be an understanding that the answer, if found, would be worth having. It is granted that one may undertake a blind study and more or less by accident make a wonderful discovery. Research work is expensive and there should be some understanding of the possibilities of a problem.

Individuals might be mentioned who have labored for years in an effort to contribute something to the advancement of knowledge, but who have failed because of lack of guidance, or of a sufficiently close objective, or both. The writer has in mind a research worker who attracted much attention by his rather startling results over a period of years, during which time he was a member of a group who had the guidance of several older men of broad experience. This man then moved to another city, where he was given ample funds and permitted to carry on as he liked. At this time one of the elders remarked that he feared that this man would not accomplish as much in his new environment, as there was no one to keep him "on the track." Subsequent events have proven that to be the case.

Would it not be worth while at this time to list the important un-

knowns in the dental field, such as dental caries, erosion, the dystrophies of the hard tissues of the teeth, infections of the investing tissues, and other diseases of the soft tissues of the mouth, and to review the related fields of scientific study, to determine as far as possible what approach to each problem might be made in the several fields? For example, in the study of *dental caries*, we might list certain work that has been or should be done in the histology and histopathology of tooth structures; in *oral anatomy*, tooth forms; in *bacteriology*, the bacterial flora of the mouth and their products; in *biochemistry*, the saliva and the action of various salivary elements on the teeth; in *physiology*, comparative studies of the saliva of persons immune or susceptible to decay; in *nutrition*, the relation of diet to the structure of the teeth and to the composition of the saliva; in *secretions*, the ductless glands, and their relation to the teeth and saliva; in *occlusion*, the forms of the teeth and of all elements of the masticatory mechanism in relation to the occurrence and surface-spreading of decay; etc.; etc. A similar statement might be made for each major dental problem. For some, the relation of the mouth condition to the general health would develop an interesting group of systemic problems, such as the causes of salivary calculus, which are doubtless closely related to, if not identical with, the etiology of gall stones, renal calculi, and other similar concretions.

Two types of charts might be made, one having the major problem in a centrally located circle, with statements of studies in related fields as radiants. This group of charts would constitute the major-problem series. The other type of chart would place a field of study in the center, as biochemistry, and the radiants would consist of all studies in biochemistry that might fall within the dental field, thus illustrating the opportunities for dental research by the chemist. A similar chart might be made for physiology, for bacteriology, etc., etc. Such charts would enable the investigator to form a better conception of the place which his problem occupied in the general scheme, and its relation to other studies. They would also suggest the importance of coördinated research in several fields, directed toward the solution of a single problem.

One of the major research-problems in dentistry today is that of securing funds for this work. During recent years the amount of

money that has been given to medical education and research in Canada and the United States has averaged more than $50,000,000 per year. Figures recently collected by Dr. Gies show that a number of dental colleges have received endowments in considerable amounts, from which, however, only one has an income of more than $50,000 per year. Doubtless a portion of this is for research, yet the total is so small as to be of little consequence in comparison with the need. Many wealthy persons are desirous of contributing large amounts to any cause that is really worth while, and it seems to be only a question of organizing our opportunities in such a way that their importance will be appreciated.

It appears to be of first importance that our field should be so analyzed and organized that there would be less scattering of effort, less repetition of good work already performed, greater coördination, and a general guidance that would incline a larger number to concentrate on a few problems. The development of a program of research not only would give each interested person a better understanding of the important relationships of every major problem, but also would place in our hands the data necessary to convince wealthy people that satisfactory returns would accrue from money invested in our work.

II. Paper Transferred to a Coördinated Session of the American Association of Dental Schools: Morning, March 24; Abstract 1

1. Research in the use of a rating scale as a means of evaluating the personalities of senior dental students[4]

Robert K. Brown, M.S., D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

Measurement of the physical world has been reduced to an exact science. It is reasonable to expect that similar progress will be made in the measurement of human traits that comprise personality. A *trait* is a mode of reaction that tends to differentiate one individual from another. *Individuality* is the sum of the measurable differences that makes a man what he is, and also shows why he differs from other men. *Personality* is an individual as perceived by others.

[4] Published in full in this issue: *Journal of Dental Research*, 1930, x, p. 271.

A graphic rating scale was chosen as the measuring instrument of the traits selected by us as being necessary for a dentist's success in his profession. This scale is the most accurate for the rating of groups of more than thirty or forty individuals. The following twenty-one traits were rated: appearance, manner and bearing, clearness of thought, judgment, decision, tact and courtesy, attractiveness, talkativeness, cheerfulness, aggression and initiative, reasonableness, tolerance and openmindedness, attention to detail, diagnostic ability, type of work, conscientiousness, coöperation, perseverance, industry, desire for improvement, and professional ideals.

Traits comprising personality are relative. They can not be measured in terms of any accurate standard. We must measure differences, which are easier to detect than either direction or amount of difference. Each trait selected was unique, distinct, and different. Our rating scale was valid, objective, and relative, as correlation tables and graphs covering two years of this work have proven. The rating of a class of over one hundred students by six instructors has enabled us to plot a personality curve giving a class-average personality, and to assign each student his position on this curve. It has enabled each student to analyze his standing for each of the twenty-one traits in comparison with that of his class as a whole for each of these traits. The student can attempt to modify his personality, for his rating scale shows his weak as well as his strong traits.

The teacher has another instrument for measuring the abilities of his students. The ratings as received from the different instructors enable the department head to evaluate the ability of his respective staff members in making judgments and comparisons of students. The teachers are rated indirectly by the use of this scale.

We are establishing correlations of clinical grades, scholastic grades, mental-test results, personality ratings, and post-graduate success in practice. These may prove valuable as well as interesting. Each student is rated twice during his senior year, and a rating scale giving him the composite results of these ratings is presented to him. This scale is a cross-section of his personality as viewed by his instructors. It is an instrument that will help him, if he desires to use it to advantage.

The field of applied psychology is teeming with possibilities. In-

dustry is utilizing it to a greater extent every year. The rating scale has been a very successful instrument as a measuring device in the business world. There is a distinct difference between the professional and industrial life, but certain phases are common and fundamental to both. The success attending the use of this means of evaluating the personnel of organizations in industrial fields was the stimulus that prompted us to make our initial studies along similar lines.

III. First Session: Evening, March 24; Abstracts 2–10

2. Report of Recent Experiments in the Control of Dental Caries

R. W. Bunting, D.D.Sc., Edna Delves, A.B., and Dorothy G. Hard, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

During the past year carefully recorded dental surveys have been made of children in five different public institutions, of which two groups were maintained on a well-balanced, well-fortified, low-sugar diet, and hexylresorcinol was used as a mouth wash. One public-school group used hexylresorcinol without change in diet. One orphanage had a good diet without hexylresorcinol. In one orphanage an unsatisfactory diet was used as a control. The results of these dental surveys are indicated in *Table 1* and in *fig. 1*.

In the two institutions, Maumee and Lapeer, in which diet and hexylresorcinol were used, oral B. acidophilus was markedly reduced,

TABLE 1

Data showing results of experiments in the control of dental caries

Group	No	Method	Time	No active caries		Active caries		Small or ? caries	
				No.	Per cent	No.	Per cent	No.	Per cent
Maumee	156	Diet + hexylres.	1 yr.	125	80	8	5	23	15
Lapeer	118	Diet + hexylres.	1 yr.	93	79	7	6	18	15
Lincoln	104	Hexylresorcinol	9 mo.	26	25	52	50	26	25
Coldwater	159	Diet	1 yr.	119	75	7	6	33	19
G. P. O.	74	Control	1 yr.	13	18	36	49	25	33

and active dental caries was almost a negligible quantity over a period of one year. Practically 80 per cent of the children had no new caries, and many had old unfilled cavities that grew no larger during the period of observation. In the Lincoln school the children were on the varied diets of private homes. Although they used hexylresorcinol daily for nine months, the incidence of caries was pronounced and extensive, having been quite similar to the control "*G.P.O.*" group. In the Coldwater school the diet was fairly well balanced, but the

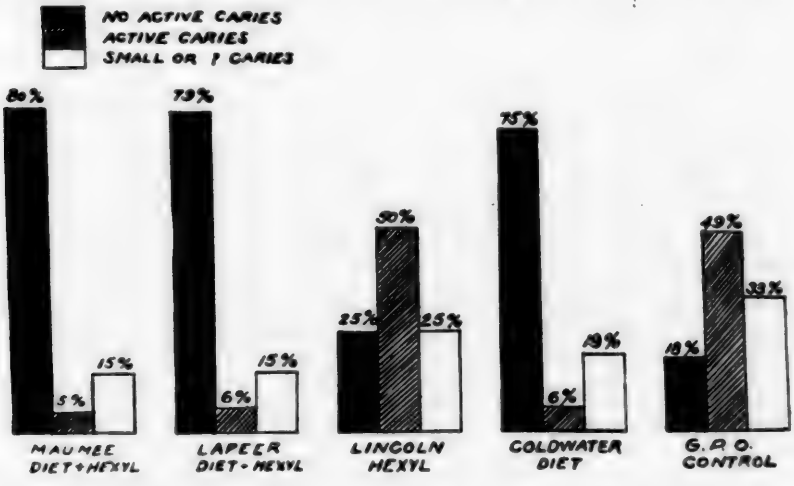


FIG. 1. GRAPHIC INDICATION OF THE RESULTS OF EXPERIMENTS ON THE CONTROL OF DENTAL CARIES

sugar, although unusually low in amount, was more abundant than in the Maumee and Lapeer groups. The dental conditions, however, were almost as favorable.

The data obtained clearly show that the feeding of adequate, well-balanced, low-sugar diets definitely decreases the growth of B. acidophilus in the mouth, and markedly inhibits the activity of dental caries. Other more detailed experiments of a similar nature are now being organized.

3. THE PREVENTION OF CARIES AND PERIODONTOCLASIA[5]

Paul R. Stillman, D.D.S., F.A.C.D., F.A.A.P., and John Oppie McCall, B.A., D.D.S., F.A.C.D., F.A.A.P., College of Dentistry, New York University, New York City

The etiology of both periodontal disease and caries has been definitely linked up with traumatic occlusion, as indicated by careful clinical observation extending over a number of years. This factor has a direct influence on the circulation in the pericementum. Because of this fact, it influences the circulation in both the marginal gingiva and the pericementum.

It is granted that a primary requisite for dental and pericemental health is the development of strong resistant tissue through the medium of proper diet. When the teeth and their supporting structures have once been formed, however, their health can only be maintained by normal function. This requires full use of the teeth in mastication, without interferences such as are commonly found in even well-formed arches. The dissipation of such interferences is accomplished only through either natural wear, or wear artificially induced by grinding with abrasive stones. The part played by natural wear may be visualized in the jaws of primitive people, whose high degree of dental health has commonly been attributed to the influence of diet, sunshine, etc.

Research workers have centered their attention on the dietary factor and with considerable success. But it is the contention of the authors that a complete solution of the problems of caries and periodontoclasia will be arrived at only when the element of function is included in the research program.

[5] Published in full in this issue: *Journal of Dental Research*, 1930, x, p. 255.

4. CONCERNING DEFECTS IN THE ENAMEL OF TEETH OF ANCIENT AMERICAN INDIANS[6]

Charles F. Bödecker, D.D.S., F.A.C.D., Laboratory of Oral Histology and Embryology, Dental School, Columbia University, New York City

Enamel fissures or flaws existed in the teeth of Pueblo Indians living in New Mexico about 800 years ago.[7] In spite of these defects, the incidence of dental caries was low (approximately 3 per cent). This paradox can now be explained by the state of their food and health. Decay was absent because (a) of thorough mastication of gritty food; (b) of subsistence on unrefined and coarsely ground food; and (c) the tribe was healthy, the individual resistance of the teeth to decay thus being high. This resistance to oral lactic-acid fermentation was probably dependent upon the constitution of the dental lymph.[8]

In spite of these observations, however, enamel fissures in the teeth of civilized man must be regarded as a severe menace to the teeth, for these minute crevices are filled repeatedly with highly fermentable carbohydrate (sugar, refined white flour, etc.), and decay therefore soon ensues.

5. SOME PROPERTIES OF ENAMEL, RECONSIDERED

Thomas A. McFall, D.D.S., Department of Physiology, Medical School, University of Pennsylvania, Philadelphia, Pa.

Many observations of apparent passage of water and salts across the enamel of dog teeth have been recorded. In repeating one of the experiments on a canine tooth of a dog, such an observation was confirmed by the author. When human teeth were used in attempts to determine osmotic passage across the enamel, the experiments failed. In most cases the flow of the liquid was opposed to the induced osmotic force.

[6] Published in full in this issue: *Journal of Dental Research*, 1930, x, p. 313.

[7] Specimens were presented to the Columbia University Dental School, through Dr. Henry W. Gillett, by Dr. A. B. Kidder, one-time chairman of the National Research Council at Washington.

[8] Bödecker: *Dental Cosmos*, 1929, lxxi, p. 586.

If the surface of enamel of apparently sound extracted human teeth be examined with a microscope, using a 12-objective and 15-eyepiece (Zeiss), and by direct illumination, many cracks may be observed. Stains placed in the pulp chamber of such teeth appear on the surface of the enamel in positions corresponding to the observed surface cracks. Histological examination of transverse sections of the crowns of extracted teeth show these cracks extending well into the enamel, and in some cases directly up to the dentine. Pickerill has observed similar cracks in the enamel. Of thirty-five first incisors, second incisors, and canines, *in situ*, of male students between the ages of twenty and twenty-five years, 60 percent presented surface cracks.

On the basis of these observations it seems logical to reconsider some of the experimental reports of passage of water and salts across enamel, along with the conclusion that enamel is permeable. It is believed that such passages have been in many cases across the cracks and, as Humphreys and Wellings[9] state, are in inverse ratio to the perfection of the structure of the enamel. The author does not conclude that enamel is an impermeable material, but feels assured that a more detailed check-up on laboratory conditions in work of this kind will go a long way towards preventing further confusion in an already nebulous field.

6. STRUCTURAL CHANGES OBSERVED IN TEETH AND JAWS OF RATS SUBJECTED TO DIET DEFICIENT IN MINERAL SALTS

John Jacob Wolfe, L.D.S., D.D.S., Yale Medical School, New Haven, Conn.

Rats thirty-six days old were placed on a diet deficient in mineral salts. After sixty-three days the animals were autopsied, and the jaws radiographed and prepared for histological study. There was marked softening of all bones and thinning of the cortex, similar to changes found in osteomalacia. Microscopically there was extreme osteoporosis, many large multinucleated cells and bone-islands undergoing dissolution. The dentin showed many dilated tubules and vacuolated areas. The pulp was a maturer connective tissue than

[9] Humphreys and Wellings: Dental Anatomy and Physiology, p. 96 (1923). Edward Arnold and Co., London.

normal, the blood vessels of which were markedly dilated. The enamel showed evidence of relative increase in the organic matrix, and of dis'ntegration of enamel rods.

7. EFFECT OF VITAMIN D ON THE HARD TISSUES OF WHITE RATS[10]

Rudolf Kronfeld, M.D., and F. J. Barker, D.D.S., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

The authors aimed to determine how far it is possible to compensate, by use of a vitamin-D preparation, the pathological effects of an insufficient diet. Rats were fed a diet rich in calcium, but completely lacking in vitamins. Some of these rats also received daily a fixed amount of vitamin D. Other rats of the same age and family were kept on a normal diet. At various intervals, animals were killed and tissues—teeth, knees, ribs, etc.—were sectioned and studied. It was evident that an abundant supply of calcium in the food could not prevent severe disturbances in the calcification. This was found in all tissues, though in varying degree. On the other hand, the vitamin-D preparation enabled the organism more efficiently to assimilate ingested calcium, and also prevented the occurrence of enamel hypoplasias, which usually were found in the incisors of rats without vitamin D. The experiments are being continued.

8. A NEW METHOD FOR DETERMINING THE COLLOID CONTENT OF SALIVA BY ELECTROPHORESIS[11]

S. S. Arnim, B.S., and H. C. Benedict, M.S., Chemical Laboratory, Dental School, Northwestern University, Chicago, Ill.

One way of testing the theory that mucin is a factor in the process of decalcification of teeth in dental caries is to analyze samples of saliva for their colloid content, which is principally mucin, and attempt to relate the amount or ease of precipitation of the mucin to the prevalence of dental caries in the subject. To this end the following research was conducted.

Saliva is normally on the alkaline side of the isoelectric point of its

[10] To be published in the *Journal of the American Dental Association.*

[11] To be published in the *Journal of Biological Chemistry.*

colloids. Therefore, they are negatively charged, although the magnitude of the charge varies with the H-ion concentration and the amount of electrolyte present. Badollet and Payne,[12] using a positively charged colloidal dye, night blue (in the determination of colloids in sugar-house liquors), showed that the combination was nearly stoichiometric. We have modified their method, which has thus for the first time been applied to the study of animal fluids, although other electrophoretic tests have been used in the study of blood and bacteria.[13]

A Leitz, slit ultramicroscope and a Northrop-Kunitz cell were used. Five cc. of saliva were diluted to 100 cc. with distilled water in a volumetric flask. After centrifuging, 10 cc. of this solution were titrated with night blue, which was freshly prepared and used in a strength of 0.2 mg. per cc. (0.02 percent). The end point of the titration is reached when the particles no longer migrate in an electrical field. The movement is observed with the aid of an ultramicroscope. A total of 90 volts was used. It was not necessary to determine the potential gradient.

A large amount of dye would mean either a correspondingly large amount of colloid, principally mucin, or an exceptionally high charge on the colloid. As the charge depends mainly on the H-ion concentration of the solution, this factor was determined in each trial. The H-ion concentration of the solutions have been quite constant at 6.3, measured by the quinhydrone electrode. Therefore, the amount of colloid present is proportional to the amount of dye used to neutralize it. This was verified by the analysis for protein, using the micro-Kjeldahl test for nitrogen. It was found that about 1 mg. of the dye neutralized 2 mg. of the colloid.

The isoelectric point of the colloid in saliva was pH 3.4 to 3.7. The colloid content of resting saliva from one subject, where the content in general was high, was about twice that of stimulated saliva. Paraffin was used to stimulate the flow. The colloid content of one of the other subjects was much lower and much more constant. About

[12] Badollet and Payne: *International Sugar Journal*, 1926, xxviii, p. 97.

[13] Northrop and Kunitz: *Journal of General Physiology*, 1924–25, vii, p. 729. Abramson: *Colloid Symposium Monograph*, 1928, vi, p. 115. Mudd, Luecke, McCutcheon, and Strumia: *Ibid.*, p. 131.

fifty determinations were made. This small number naturally allows no definite conclusions.

9. REPORT OF TWO CASES OF ROOT RESECTION SHOWING REPAIR AFTER FOURTEEN YEARS

Edgar D. Coolidge, B.S., D.D.S., F.A.C.D., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

The root-end of an upper central incisor had been resected following canal filling. The tooth carried a crown for more than fourteen years, and then was fractured in use. The microscopic sections showed that a deposit of cementum had covered most of the resected surface of dentin and cementum. The condition of the periodontal tissue was also very favorable.

The second case[14] was one of an upper bicuspid root, which was resected after filling the canal. This root was surrounded by a large area of chronic inflammation before the resection, as revealed by roentgen examination at that time. After fourteen years the root was extracted. On microscopic examination, a complete layer of cementum was found upon the entire resected root-end, covering both the old cementum and all of the exposed dentin. New peridental fibers were present where the infected root-end and surrounding tissue had been previously removed surgically. There were no inflammatory cells of any kind in the new soft tissue surrounding the root-end.

10. STUDIES ON THE BACTERIA IN DENTAL PERIAPICAL INFECTIONS

Henry A. Miller, D.D.S., Yale Medical School, New Haven, Conn.

The author described a technic for securing dental periapical cultures in a correlated bacteriological study of the human body at autopsy. The findings in nineteen cases showed S. viridans pure, fourteen times; S. fecalis pure, twice; S. viridans and Staph. aureus, once; S. viridans, Staph. aureus, and a diphtheroid, once; and S. viridans and B. coli, once. By Holman's sugar-fermentation reactions, these organisms were classified as S. mitis, seventeen times; S. salivarius, eight times;

[14] Coolidge: Proceedings of the Chicago Section of the International Association for Dental Research, *Journal of Dental Research*, 1930, x, p. 133.

S. ignaveus, four times; S. fecalis, twice. The dissociation forms, i.e., rough and smooth colony-forming organisms, were studied for agglutination reaction with four sera. The dissociation forms of the individual case showed marked difference in their reactions. All the strains when together, however, showed a tendency to group themselves into (a) those not agglutinating with the sera at hand—9; (b) those agglutinating with a serum made from a smooth-colony-forming organism—2; (c) those agglutinating with another smooth-colony-forming organism—5; and those agglutinating with two sera made from rough-colony-forming organisms of two different cases—11.

Reference was made to the work of Burn, who studied the bacterial flora of the organs and body fluids of these cases.

IV. Papers Transferred to a Coördinated Session of the American Association of Dental Schools: Afternoon, March 25; Abstracts 11–13

11. Relationship between migrating teeth and inflammatory tissue in pyorrheal pockets

Isador Hirschfeld, D.D.S., School of Dentistry, Columbia University, New York City

That a pyorrheal pocket is frequently found in the wake of a pathologically drifting tooth was pointed out by Gottlieb and by Box. The former has also alluded to the fact that the inflammatory tissue in such a pocket may be a motive power in the "wandering" of such a tooth. These writers, however, have evidently described the tooth in its eccentric migration and position. The essayist prognosticates its return, like a pendulum, to its original place and position without any orthodontic aid, once periodontal health is restored. He has been able to obtain this clinical result on numerous occasions, but not invariably. In line with this thought he also described instances in which, as a result of successful periodontic treatment, numerous interdental spaces, pathologically produced by the expanding pressure of inflammatory tissue, diminished or were entirely eliminated, with a resultant marked shortening of the various diameters of the dental arch. Instances were also pointed out in which subgingival inflammatory

tissue, through its tenacity, acted as a prop to a periodontally undermined tooth, retaining it in its approximately normal position. With the diminution and finally complete disappearance of such tissue as a result of successful periodontal treatment, the affected tooth tends rapidly to drift obliquely in the direction of the space formerly occupied by the inflammatory tissue.

A consideration of primary importance is the diagnosis of the cause directly responsible for a certain subjective symptom occasionally noted in practice, which is the feeling of continuous interproximal pressure as if produced by the tight wedging of food, but where food is not actually present. This may be produced by the persistently expansive action of sub-gingival inflammatory tissue situated not in the interdental space so affected, but on the opposite side of one of the two teeth. The symptom may cease with decrease in the aforementioned inflammatory tissue, and may not return so long as the periodontium remains healthy.

12. THE CONCEPTION OF A CIRCULATION OF LYMPH IN DENTINE AND ENAMEL

Samuel W. Chase, A.M., Ph.D., Laboratory of Histology and Embryology, Western Reserve University, Cleveland, Ohio

Solutions of methylene blue, of methyl blue, and of ferrous ammonium citrate, used according to the methods of Fish in dog teeth, penetrate the dentine and enamel as extensively and as rapidly in dead teeth as in living teeth, provided like conditions of temperature, pH, and supply of solvent are maintained.

India ink injected into the pulps of dog teeth, by the method of Fish, penetrates the dentinal tubules only at areas where the odontoblasts have been scraped or pulled away from the pulpal surface of the dentine by the hypodermic needle. The distance to which the ink penetrates along a tubule depends chiefly on the length of odontoblastic process pulled out of the tubule, although some ink penetrates between the odontoblastic process and the wall of the tubule, probably when the process is reduced in diameter by stretching. Under these conditions, the penetration of India ink into the dentinal tubules occurs in teeth *in situ* during life and after death, and also in extracted teeth long preserved in 10 percent formalin.

From these findings it is concluded that the experiments of Fish do not prove the presence of a circulation of lymph in the dentine and enamel.

13. BLOOD-COUNTS AND URINALYSES IN CASES OF PERIAPICAL INFECTION, BEFORE AND AFTER TREATMENT[15]

C. K. Bryant, B.S., and K. Polevitzky, M.D., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

Blood. Before treatment, these patients showed a deviation from normal in their blood pictures in the following respects: slightly lowered hemoglobin content, 9 percent; slight decrease in number of red blood-cells, 43 percent; *decrease* in number of leukocytes, 25 percent; *increase* in number of leucocytes, 25 percent; *decrease* in percentage of all types of neutrophiles, 50 percent; *increase* in percentage of all types of neutrophiles, 16 percent; and *increase* in percentage of lymphocytes, 69 percent. In the differential neutrophile count, the average percentage of types I and II together was greatly increased, showing a marked deviation to the left. The blood pictures showed a tendency to swing back toward normal, after treatment for removal of the foci of infection. Especially was this true of the numerical leukocyte count, and of the neutrophilic and lymphocytic percentages. The percentages of the five types of neutrophilic cells showed the least tendency to swing back to normal, remaining almost unchanged after a lapse of one month.

More improvement has been shown in the chemotherapeutic cases than in the surgical. This is difficult to explain unless it be due to the fact that the cases in apparently poorer general condition were as a rule treated surgically, i.e., cases which, by reason of their lowered resistance, seemed unsuited to the uncertainties of the chemotherapeutic technic in its present unproven status. Included in the surgical group were also several patients who had failed to respond to chemotherapeutic treatment, i.e., failed to give a negative culture.

Urine. Of the *first* group of sixteen patients, 56 percent showed albumin; 38 percent, casts; 69 percent, indican. Sugar was not found in any instance. Of the *second* group of fifteen patients, 7 percent

[15] Published in *Dental Cosmos*, 1930, lxxii, p. 363; April.

showed albumin; none, casts or sugar. No tests for indican were made.

These studies emphasize the fact that infection in the mouth is a serious condition, and that it brings about important changes in the organism as a whole. Further studies are being carried out on a more carefully selected group of patients.

V. Second Session: Evening, March 25; Executive Proceedings

14. President's Address

Arthur D. Black, A.M., M.D., D.D.S., Sc.D., F.A.C.D., Dental School, Northwestern University, Chicago, Ill.

Published in full on pages 368–372. This address was followed by the annual business session. See page 420.

VI. Third Session: Afternoon, March 26; Abstracts 15–22

15. Relative Antibacterial Effects of Different Electrodes Used in Electrosterilization

Louis J. Grossman, D.D.S., Dr. med. dent. (Rostock), and J. L. T. Appleton, Jr., B.S., D.D.S., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

The effects of three electrodes on the degree of antibacterial action were studied. The antibacterial effect depends upon the nature of the electrode as well as upon the electrolyte. A zinc electrode gives a greater antibacterial effect than an iridio-platinum one, when the electrolyte used is sodium chlorid. When the electrolyte is zinc chlorid, or a zinc iodid-iodin solution, there is practically no difference in the degrees of antibacterial power. While Wipla (V_2A) steel showed a greater antibacterial action than iridio-platinum (although less than zinc), it was eliminated because with its use extracted human teeth became discolored. Coating the iridio-platinum electrode with zinc, either by electroplating or by dipping into molten zinc, is impractical from a clinical standpoint. It is advantageous to use a pure-zinc electrode when sodium chlorid is the electrolyte. For practical purposes, an iridio-platinum electrode is preferable when the electrolyte is a zinc salt.

16. STUDIES, AT AUTOPSY, ATTEMPTING TO CORRELATE DENTAL AND SYSTEMIC PATHOLOGY; ILLUSTRATED WITH MOVING PICTURES

William G. Downs, Jr., M.A., D.D.S., and James P. Pigott, D.D.S., Yale Medical School, New Haven, Conn.

This film showed the methods and technic in use at the Yale Medical School by which a new bacteriological and histopathological study is being made of the teeth and jaws of individuals coming to autopsy in this institution. In these studies swab cultures are taken from the oral mucosa and full-mouth radiograms are made. Suspicious areas are also selected, as well as similar negative blocks for controls. Before access is gained, such areas are carefully sterilized on the surface to eliminate the possibility of contamination. Cultures are then taken and grown both aerobically and anaerobically, and compared with the bacteriological pictures relating to other organs and tissues of the body. These blocks are then decalcified, sectioned, stained, and studied for histo-pathological changes. Statistical studies are also made of all these cases.

17. EFFECTS OF MASTICATORY STRESS UPON THE SOFT TISSUES IN EDENTULOUS AREAS OF THE RIDGE

Walter H. Wright, D.D.S., F.A.C.D., School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

The author presented a progress report on a study of tissue reaction to (1) entire lack of pressure, (2) brushing action of food, (3) direct contact of opposing teeth, and (4) pressure exerted by a denture. Conclusions were drawn from numerous sections taken from mouths of cadavers and patients. Tissue reactions were uniform in the several groups, warranting the following general statement.

Normal soft tissue presents a rather regular arrangement of the structural elements. Lack of functional activity is manifested by loss of the elements designed to take care of stresses. Stress upon these tissues produces a rearrangement of the elements so that they function most efficiently. Abnormal stress causes a marked derangement of the elements. When this stress is confined to a small area, round-cell infiltration commonly occurs. Cornification is usually present where

the tissue is exposed to the brushing action of foods or to contact with opposing teeth. It is very slight when found under dentures. Tissues under dentures may maintain a healthy condition providing stresses are applied in a normal manner. When stresses are abnormally applied to a denture, the underlying tissues frequently show a marked consolidation associated with round-cell infiltration.

18. A STUDY OF THE NUTRITION AND TEETH OF THE ESKIMO OF NORTH BERING SEA AND ARCTIC ALASKA[15a]

Leuman M. Waugh, D.D.S., F.A.C.D., Dental Surgeon (R), United States Public Health Service; Associate Dean and Professor of Orthodontia, School of Dentistry, Columbia University

On July 1, 1929, the writer was ordered to active duty under the terms of his commission as a dental officer in the Reserve Corps of the U. S. Public Health Service, and detailed to the U. S. Coast Guard for duty on board the Coast Guard cutter *Northland*. This detail afforded opportunity for the continuance of a study of dental conditions of the Eskimo of North America. From 1924 to 1927 the summer months had been utilized for a survey of the Eskimo of Labrador.[15b] Therefore, this assignment was received with keen anticipation, because it afforded opportunity to compare dietary habits, mental and physical traits, as well as dental conditions, of the Eskimo of Northern Alaska with those of the Eskimo of Labrador.

The *Northland*, a new cutter designed for Arctic cruising and built in 1927, has a complete modern dental equipment, including electric unit with all attachments and an efficient dental x-ray machine. Owing to a shortage of dental officers in the Public Health Service, no dentist had previously been assigned to the *Northland*, and this complete dental service was the first to invade Arctic Alaska. For the convenient gathering of data the accompanying questionnaire was prepared for the missionaries, government teachers, nurses, etc., from whom information was sought. The answers were tabulated in the form of six charts on (1) living conditions, (2) foods, (3) teeth,

[15a] A full report of the study will be published by the U. S. Public Health Service.

[15b] Waugh: Proceedings of the Sixth General Meeting of the International Association for Dental Research, *Journal of Dental Research*, 1928, viii, p. 428.

TABLE 2 (CHART II)

Data relating to the diet of Eskimo of North Bering Sea and Arctic Alaska

LOCATION	FOOD CONSUMPTION			VEGETABLES						
	Fats	Protein	Carbohydrates	Wild vegetables?	Cooked or raw?	Description; quantity	Gardens?	Tinned vegetables?	Kind and quantity	Other information
	per cent	per cent	per cent							
Alaska: general	30	45	25	Yes	Raw	Seaweed; summer greens	No	Rarely	Cannot estimate	
St. Michael[1]	40	10	50	Yes	Both	Greens in seal oil	No	Moderately		
White Mountain	50	30	20	Some	Raw	Sour dock, berries	No	Very little	Negligible	
Nome	...	...	...	Yes	Raw	.....	No	Occasionally		
Nome	...	...	...	Yes	Raw	Small quantity	No	Yes		
Reindeer Station	25	60	15	Yes	Raw	Wild onions	No	Very little	.....	Tinned fruits and jelly preferred
Savoonga	25	50	25	Yes	Both	Sea and land vegetation	No	Yes		
St. Lawrence Island	50	30	20	Yes	Both	Berries, tubers	No	Large quantity	Peas, corn	
Gambell	20	60	20	Yes	Both	Roots, seaweed	No	Small quantity	.....	Fruits; dried and canned
Diomede, etc.	50	25	25	Yes	Both	All they can get	No	Very little	Negligible	
Kotzebue	20	30	30	Greens	Cooked	.....	Few	Not much		
Noatak	...	...	...	Yes	Cooked	Onions	No	Some		
Pt. Hope—Tigara	60	20	20	Roots	Raw	.....	No	Very few	One can per person yearly	Like bacon, candy—poor in quality
Pt. Hope—Arctic	55	15	30	No	.....	.....	No	Mostly unable		
Wainwright	40	40	20	No	.....	.....	No	Seldom	Corn, tomato	Want canned fruits in trade for furs, etc.
Pt. Barrow	66	...	34	No	.....	.....	No	Very seldom	Beets, potato	
Pt. Barrow	...	...	...	No	.....	.....	No	Yes	Soups, sweet potato	

[1] The graduate nurse evidently misunderstood, and gave the proportions of a so-called balanced diet.

TABLE 3 (CHART III)

Data relating to the teeth of Eskimo of North Bering Sea and Arctic Alaska

LOCATION	TOOTH TROUBLES	HOW OVERCOME?	TEETH OF OLD PERSONS GENERALLY SUPERIOR?	REASON FOR INFERIORITY?	TEETH CLEANED?	IF CLEANED, HOW?	ANYTHING ELSE BEARING ON SUBJECT
Alaska: general.....	Yes	Extraction	Yes	Increased ingestion of carbohydrates	No		
St. Michael.....	Yes	.....	Yes	Sweets	Yes	.....	Children taught to clean teeth; do well while at school
White Mountain....	Yes	Extraction	Yes	Change of diet	Children: yes; adults: no	.....	Children taught to clean teeth; older natives negligent
Nome.....	Yes: generally suffer	.....	Yes	Diet	Seldom		
Nome.....	Yes	.....	Yes				
Reindeer Station....	No	Extraction	.....	.....	No	.....	Children taught to brush teeth; women abrade teeth chewing raw skins prepared for sewing
Savoonga.....	Yes	Extraction	Think so	Soft sweet food	Yes	Reindeer sinew used like dental floss	Children clean teeth daily in school; 6 families use brush
St. Lawrence Island.	Yes	Extraction	Yes	Use of sugar	Yes	.....	School children taught to care for teeth

TABLE 3 (CHART III)—*Concluded*

LOCATION	TOOTH TROUBLES	HOW OVERCOME?	TEETH OF OLD PERSONS GENERALLY SUPERIOR?	REASON FOR INFERIORITY?	TEETH CLEANED?	IF CLEANED, HOW?	ANYTHING ELSE BEARING ON SUBJECT
Gambell.....	Yes	Extraction	.....	.....	.....	.....	School children given brushes
Diomede, etc.....	Yes	Extraction	Yes	Change of food	Sometimes	Brush	
Kotzebue.....	Some	Suffer or pull	Think they are	White man's food	Rarely	.....	Some have tooth brushes
Noatak.....	No	.....	.....	.....	Yes	.....	Some young people brush teeth; women's teeth worn down
Pt. Hope—Tigara...	No	Extraction	Yes	White man's food	Yes	Ivory toothpick	Use toothache drops
Pt. Hope—Arctic...	Yes	Mostly extraction	Yes	Mixed diet	Some do	Brush and dentifrice	Visit of expert dentist of untold value this year; desired annually
Wainwright.....	No	Teacher or doctor extracts	All have good teeth	Food	Seldom	Walrus whiskers used as toothpicks	Older women's teeth worn to gums; muklak soles chewed in making and for use
Pt. Barrow.....	Yes	At hospital	Yes	Sugar and sweets	Yes	Brushes and paste distributed by hospital	When teeth are lost, indigestion is common; erroneously called heart disease
Pt. Barrow.....	.....	Go to doctor	Yes	Sugar, flour and candy	Not regularly	Brushing	

(4) diseases, general, (5) diseases, special, (6) educational. Charts II and III are given here as *Tables 2* and *3*.

Conclusion. The Eskimo of North America is paying for his civilization with his teeth.

QUESTIONNAIRE RELATING TO ALASKAN NATIVES

For Dr. Waugh, Dental Surgeon, USPHS (R) detailed to the Cutter NORTHLAND, for cruise in Alaskan waters to Barrow in 1929

(Kindly answer as many as you can. Use back of sheet if necessary)

Name of settlement.....Race.....
Health.....General condition.....Population.....
Illnesses.....most common.....
Epidemics.....most common.....Dates.....
Endemic diseases (infections).....
Dwellings.....Types of.....
Sanitary precautions.....
Bathing habits.....
What care is given new born infants.....
What kinds of clothing are worn.....

Mortality

How many of the natives have: (a) Tuberculosis { Pulmonalis..... / Closed cases.....
(b) Syphilis { Acute..... / Chronic.....
(c) Gonorrhea { Acute..... / Chronic.....

What are the sources?.....
What sequelae are observable?.....
Do you feel that they are important contributing causes in lowering the life expectancy?.....
What opportunities for: School training.....
Vocational training.....
Church training.....

Kindly check the foods in your territory:

Fats	*Protein or nitrogenous*	*Carbohydrates*
Seal blubber or oil	Red meats of reindeer	Sugars
Whale blubber	Caribou	Molasses
Walrus fat	Seal	Candy
Cod oil	Trapped animals	Potato
Salt pork	Fish	White flour
Cow butter	Birds	Oatmeal
Margarine	Eggs	Wheat cereals
	Cow milk	Cornmeal
	Goat milk	Rice
	Tinned milk	Beans
	Bear	

Give estimate of total percentage of (a) fats.....; (b) proteins .....; (c) carbohydrates consumed..... taking all food eaten as 100 percent.

Vegetables

Are wild vegetables eaten as buds, grasses, etc?.....Cooked or raw....
If so, in what quantity; and name or describe them.....
Do they have gardens?.....
Do they buy tinned vegetables?.....
If so, what kinds and how much per person per year?.....
Give any other information regarding food.....

Teeth

Do they suffer much from tooth troubles?.....
How do they overcome them?.....
Are the teeth of the older generations decidedly better than the younger?.....
To what do you attribute this?.....
Do they ever clean their teeth?.....If so, how?.....
Add anything bearing on this subject.....

Please be sure to fill in the following:
Your name:.....
Alaska address:.....
Home address:.....
Are you serving as: (a) Physician....(b) Missionary....(c) Govt. teacher....(d) Nurse....

How many years have you worked in this capacity in Alaska?.....
I should like to quote you in my official report, but shall not do so without your consent. May I use your name?.....
Mail to:
Dr. L. M. Waugh,
576 Fifth Ave.,
New York, N. Y. (Signature) ——————————

19. THE RÔLE OF THE ANTERIOR LOBE OF THE PITUITARY IN GROWTH CHANGES, WITH SPECIAL REFERENCE TO TEETH AND BONES[15c]

William G. Downs, Jr., M.A., D.D.S., Yale Medical School, New Haven, Conn.

Many observations were made on the chemical content of the tissues of *mice* on pituitary medication, and of the effect of this medication on the teeth and jaws. Gross and microscopic examinations were also made of the effects of pituitary medication and hypophysectomy on the teeth, jaws, and viscera of *dogs*.

It was concluded that the *pituitary* had a definite effect upon growth, causing increased water-retention in the tissues, increased calcium retention, and decreased fat formation. It influenced the development of teeth and jaws in the direction of accelerating the growth of the teeth, and somewhat increasing the size of the maxillae, but did not cause malformations of any sort or absence of teeth in either its hyper- or hypo-secretion. A comprehensive bibliography of the endocrine and metabolic literature as applied to the dentition will be included in the published paper.

20. A STUDY OF CERTAIN PHYSICAL AND CHEMICAL PROPERTIES OF SALIVA IN RELATION TO DENTAL CONDITION IN CHILDREN

J. Stanley Bagnall, D.D.S., and E. Gordon Young, Ph.D., Dental School, Dalhousie University, Halifax, N. S.

A study of the saliva of twenty-eight children of school age has been made in conjunction with routine dental examination and treatment. H-ion concentration, surface tension, viscosity, and mucin content of

[15c] To be published in an early issue of the *Journal of Dental Research*.

the "resting" saliva have been determined. It has been found that the surface tension of saliva varies within very narrow limits, and is only slightly lower than that of water. The pH variation in this series was between 7 and 8, suggesting a more alkaline saliva than in the case of adults. In a series of seven perfect mouths, the pH was close to neutrality. The mucin content was always low in these cases. Viscosity of saliva bears no direct relationship to mucin content.

21. CORRELATION OF RADIOGRAPHIC AND HISTOLOGIC FINDINGS IN RESIDUAL INFECTION

John Oppie McCall, B.A., D.D.S., F.A.C.D., F.A.A.P., College of Dentistry, New York University, New York City

The studies reported in 1929 have been continued.[16] This has resulted in showing that aberrations in the tissues tend to fall under the head of "fibrosis" or of "round-cell infiltration," usually under both. Polymorphonuclear cells are seldom found, and osteoclasts are also rare. Bone inflammation tends to be of the productive type. There may be hyperplasia of the cellular elements of the marrow. Plasma cells may be present in great numbers; or, at the other extreme, may be so few as to give a field of nearly normal appearance. The indications are usually those of a very low-grade infection inducing mild reaction, as in the case of many periapical infections.

22. REVIEW AND FURTHER STUDIES OF VINCENT'S INFECTION[17]

Francis H. Daley, D.M.D., Tufts College Dental School, Boston, Mass.

The paper was divided into a number of short sections, each dealing with a particular phase of the disease. They included a review of the literature for the past forty-five years, coupled with the findings of four years of intensive study on the clinical aspects of Vincent's infection. These sections were (1) history, (2) bacteriology, (3) etiological factors, (4) methods of smearing and staining, (5) clinical and differential diagnosis, (6) microscopical diagnosis, (7) methods of treatment, (8) methods of transmission, (9) dangers of operative or

[16] McCall: *Journal of Dental Research*, 1929, ix, p. 289; 1930, x, p. 113.
[17] To be published in the *Journal of the American Dental Association*.

surgical work in presence of Vincent's infection, (10) report on incidence, and conclusions drawn from a study of 3,771 smears and case histories, and (11) references numbering approximately three hundred items, including articles and texts written in the United States and seven foreign countries.

The author concluded, in general, that the dentist, by proper prophylaxis, may prevent many cases of Vincent's infection, which can and should be treated by methods that do not cause destruction of the hard and soft tissues of the oral cavity. The technique of smearing and staining for clinical diagnosis can be completed, from smearing to diagnosis, within three to five minutes. Proper case-histories are essential in making a differential diagnosis. Vincent's infection is a communicable disease, and the dangers of operative or surgical procedure in its presence were stressed.

VII. Fourth Session: Evening, March 26; Abstracts 23–30

23. Some theories obstructing the progress of the science of orthodontia

George W. Grieve, D.D.S., Toronto, Canada

The author criticised some of the theories of diagnosis and also some of the generally recognized methods of treatment of malocclusion, chief of which is the almost universal belief that in many cases falling in Angle's Class-II, the mandibular teeth occupy a distal position in relation to the main body of the mandible. He stated that "the idea that the mandibular teeth in these cases are distal to their normal position in relation to the main body of the mandible is one of the most colossal mistakes that has been made in orthodontic diagnosis." After many years as a specialist in the practice of orthodontia, he found that numerous cases of this type, which had been treated by the use of intermaxillary elastics, lapsed more or less. This applied not only in his own practice, but also, as shown by the literature, in that of many other orthodontists. He quoted the work of several authors to bring out this point; and of some of these, as well as others, to show that he is not alone in the belief that certain theories and present-day methods of practice are erroneous.

The author said that several years ago it was his belief, although not stated definitely at that time, "that teeth were rarely, if ever, distal to their normal position in relation to the apical base in any class of malocclusion, except possibly where there was mutilation, missing tooth-germs, or something of that nature." He stated that this is still his belief, and that he is now prepared to go on record to this effect. He further said: "It is apparent that several investigators are gradually arriving at the same conclusion, viz., that teeth drift forward, not only in the maxillae, but also in the mandible." In conclusion he stated that he "desires to stress what he has endeavored to make the main theme of this paper, viz., that, in his opinion, teeth ordinarily do not occupy, in either maxillae or mandible, a position distal to their normal relation to the main body of the bone in which they are situated, and that a lack of realization of this fact has been responsible for much of the difficulty and more or less of the failure in the treatment of malocclusion."

24. THE IMPORTANCE OF DIET FROM THE STANDPOINT OF THE DENTIST

Frederick F. Tisdall, M.D., Nutritional Research Laboratories of the Hospital for Sick Children, and Department of Paediatrics, University of Toronto, Toronto, Canada

The theory of dental decay usually accepted is the one advanced some forty years ago by Miller, who believed decay occurs in two stages. The first stage is the production of acid in the mouth by the bacterial fermentation of carbohydrates. This acid dissolves the calcium of the teeth. The second stage is the production of bacterial enzymes, which act upon and destroy the organic material in the teeth. In the light of modern biochemical knowledge, the acid theory does not appear feasible. Saliva can neutralize very large amounts of acid, so that it would be almost impossible to have a high concentration of acid in the mouth. The second point is that tertiary calcium phosphate, the main constituent of the teeth, is not easily soluble in dilute acid. According to Prof. M. T. Hanke, of Chicago, microscopic examination of carious enamel material, obtained from the dentine side of the tooth, shows the presence of disorganized enamel-rods either singly or in groups, as if the organic cementing material that

binds the rods together had been dissolved away. This indicates that it is not an acid condition of the mouth, but proteolytic enzymes produced by bacteria, which is the important factor in tooth decay.

The medical consideration of any disease involves two factors: the resistance of the individual against the disease, and the virulence of the attacking bacteria. Miller's theory does not consider the degree of resistance of the tooth against the attacking bacteria. The prevalence of tooth decay in mothers during pregnancy and lactation indicates the importance not only of keeping the mouth condition normal, but also of maintaining the normal metabolic processes in the tooth. In other words, the dentist's task is to see not only that the mouth conditions are good, but also that the diet is so regulated as to make the tooth resistant against decay.

The chief faults in the present-day diet are deficiencies of vitamins and mineral salts. Prof. Hanke has shown that, when the diet contains large amounts of vitamins and mineral elements, disease of the gums and decay of the teeth are stopped. His daily diet is based on two eggs, two glasses of milk, one-half head of lettuce, and one pint of orange juice, with whatever other food the patient desires.

The author then showed lantern slides illustrating the effect on the body of a lack of the different vitamins; also the work of the Nutritional Research Laboratories in devising a food-product in biscuit-form containing five of the six vitamins, and also calcium, phosphorus, iron, and copper.

25. SOME CONCLUSIONS ARRIVED AT AFTER A STUDY OF ULTRAVIOLET RAYS

Robert J. Reade, M.A., M.D., D.D.S., Toronto, Canada

A review of a paper which had been published by the Canadian Dental Research Foundation. Copies may be obtained from the Secretary, Dr. E. A. Grant, 86 Bloor Street West, Toronto.

26. INVESTIGATION OF THE ANGLE AT WHICH INSTRUMENTS SHOULD BE SHARPENED TO PROVIDE EFFICIENCY

Thomas E. Hayhurst, B.Sc.D., D.D.S., L.D.S., Faculty of Dentistry, University of Toronto, Toronto, Canada

Following a discussion of devices for the purpose of sharpening instruments, the question arose as to the correct angle at which instruments should be sharpened. Opinions differed, and it was discovered that apparently in none of the trades or professions where edged tools and instruments are used had any scientific investigation been made to determine this angle. Through the courtesy of supply houses, the author had access to large stocks of unused instruments. By measuring the angles at which these instruments were sharpened, he found that there was a surprising lack of standardization not only between similar instruments of the different manufacturers, but also between the supposedly identical instruments by the same manufacturer. In the trades a cold-chisel, used for cutting hard, tough, or crystalline substances, is sharpened at a very blunt angle, the cutting edge being backed with additional metal to prevent chipping, while a wood chisel is sharpened at a much finer angle, since it is used to cut a much softer material. If the power is applied by blows, then the cutting edge must be reinforced; but, if the power be applied as a steady pressure, then the angle of the sharpening bevel may be much more acute. This would indicate that a fairly coarse angle should be used to obtain the best service, were it not for a law the author conceived and has established, namely; *the more acute the angle of the sharpening bevel, the less pressure is required to force it into a substance.* Thus it will be seen that compromise is necessary—the angle must be made fine enough to cut easily, yet coarse enough to stand up for a reasonable period.

To determine this angle, the following tests were carried out on specially designed machines: (1) perforation or pressure test; (2) endurance or destruction test. The *perforation test* was for the purpose of measuring the pressure required to force into a substance an instrument sharpened at a certain angle. The *endurance or destruction test* was for the purpose of comparing the relative destruction sustained by the cutting edges of the instruments. Comparisons were

made by means of (1) photomicrographs of the cutting edges, taken before and after the destruction test; and (2) perforation or pressure readings obtained before and after the cutting edges were destroyed. A very peculiar point was brought out by the photomicrographs of a complete set of the test instruments after the destruction run: apparently the angle of the sharpening bevel has little to do with the relative destruction of the cutting edge, provided the instrument is applied with steady pressure and in a line perpendicular to the surface of the substance. The rule stated previously, that the more acute the angle of the sharpening bevel the less pressure is required to force it into a substance, is easily proven by the perforation or pressure test.

Although this work has not been completed in every phase, the observations to date warrant the following general conclusion: providing the tissue is of average hardness (e.g., dentine), and is to be cut by steady pressure, the angle of the sharpening bevel should be 35°; but, if the tissue is hard and of uneven texture (e.g., enamel), or if the force is applied by blows, then the angle of the sharpening bevel should be 45° to 50°.

27. CHRONIC FOCAL INFECTION EXPERIMENTALLY PRODUCED[18]

V. H. Moon, B.A., M.Sc., M.D., Jefferson Medical College, Philadelphia, Pa.

The methods commonly used for infecting animals are not suited to the study of chronic focal infection. Usually the inoculated animals either succumb or recover promptly, and the procedure does not approximate the conditions present in human disease. A new method for producing chronic foci of infection is here reported. Applicators of cotton, similar to those commonly used for throat swabs, are made upon # 20 and # 22 rustless wire, rather than upon wood. The cotton is wound loosely so that moderate force will slip it off the wire. A trocar and canula are inserted into the region to be inoculated. The trocar is then withdrawn, leaving the canula in place. The cotton applicator is dipped into the material to be inoculated, and is inserted through the canula. The swab is pushed quite beyond the end of the canula; then, upon withdrawing the wire, the end of the canula pushes

[18] To be published in the *American Journal of Pathology*.

off the cotton into the tissue or cavity desired to be infected. The canula is then withdrawn.

The method is merely a simplified procedure for implanting infection in a porous substance within the tissues. The foreign substance serves to maintain the infection against effective body resistance. The method is well suited for producing chronic foci in subcutaneous and intramuscular areas, and in body cavities. By exposing the abdominal viscera, the infection may be implanted easily in the spleen, liver, gall bladder, or other structures. In such instances, a smaller canula and correspondingly smaller applicators are used. In small animals a large spinal-puncture needle makes a suitable canula. The cotton swab, on fine stiff wire, is wound small enough to pass readily through the lumen of the needle. Dogs are so resistant to ordinary inoculations that they are seldom used for the purpose. They are well adapted to this method. When inoculated with streptococci, masses of inflammatory granulations 3 cm. to 5 cm. in diameter develop in a few weeks. The organism inoculated is regularly recovered from the area, and frequently from the blood and from the substance of other organs. Hemolytic streptococci and Streptococcus viridans may be recovered in pure cultures in six to eight months after implantation.

The organic changes produced in young dogs and rabbits include acute nephritis of varying types, verrucose endocarditis with rheumatic nodules in various tissues, acute vegetative endocarditis with multiple infarcts, peri-arthritis, osteo-arthritis with ankylosis and deformity, myositis of skeletal and cardiac muscles, splenic atrophy and fibrosis, periportal hepatic inflammation, proliferative endarteritis, etc.

28. NEW AIDS TO HISTOLOGICAL TECHNIQUE APPLICABLE TO PREPARATION OF SECTIONS OF TEETH AND BONE

Samuel W. Chase, A.M., Ph.D., Laboratory of Histology and Embryology, Western Reserve University, Cleveland, Ohio

A simple device for prolonged continuous change and agitation of fluids during washing, fixing, or decalcifying processes, consists of a large flask, fitted with a delivery tube passing through a one-hole stopper, filled with fluid and inverted on a ring-support over a small

stender-dish containing the specimen. The distal end of the delivery tube being set at a level below that of the rim of the specimen-dish, fluid flows from the flask until the end of the tube is sealed. A capillary siphon of a caliber selected to deliver at a desired rate is used to drain fluid from the specimen-dish. Periodically, when the fluid is drained to a level below that of the end of the tube, a large bubble of air passes into the flask and a volume of fluid rushes from the end of the delivery tube, agitating the fluid in the specimen-dish, the process continuing until the flask is emptied.

Commercial dissolved celluloid, in the form of Dupont's Household Cement, has several advantages over Canada balsam when used as an adhesive for affixing specimens to a mount during the processes of grinding and polishing thin sections. Commercial clear celluloid lacquers can be used instead of Canada balsam in the Koch (-Weil) petrifaction method of preparing thin ground-sections of teeth and bones with the soft parts in place. These lacquers can be used instead of celloidin solution in the White method of impregnating dentinal tubules, lacunae and canaliculi of bone, and interglobular spaces.[18a]

29. THE EPITHELIUM IN DENTAL GRANULOMATA[19]

Thomas J. Hill, D.D.S., Institute of Pathology, and Dental School, Western Reserve University, Cleveland, Ohio

A histological study of dental granulomata, with special reference to the role of the epithelium examination by the use of serial sections, has shown that all granulomata contain some epithelium. The epithelium is an actual transition from epithelial rests of Malassez, and retains some of the morphological and staining characteristics of the epithelium of the enamel-organ. The cystic areas within granulomata are the result of epithelial necrosis due to the avascularity and poor nutrition of this tissue. The presence of bacteria within the tissue-sections occurs only in areas of epithelial necrosis, and in the immediately adjacent tissue.

[18a] The subjects mentioned in this paragraph are discussed more fully on preceding pages of this issue: *Journal of Dental Research*, 1930, x, p. 251.

[19] Published in full in this issue: *Journal of Dental Research*, 1930, x, p. 323.

30. THE GOTTLIEB METHOD OF CHECKING THE EFFICIENCY OF TREATMENT OF PERIAPICAL INFECTION[20]

Thomas J. Cook, D.D.S., Dental School, University of Pennsylvania, Philadelphia, Pa.

Fifteen patients were selected for this study, and one tooth extracted from each. Five of the fifteen extracted teeth were normal vital ones; five were pulpless, which on roentgenographic examination were negative; the remaining five gave evidence of periapical involvement. The apices of the fifteen extracted teeth were severed and placed within the leg muscles of rats close to the femur, and the wounds then closed with muscle and skin sutures. The rats were carefully kept, and at the end of six months killed with chloroform. The tissues containing the root apices were placed into formalin, then decalcified and sectioned.

Each of the five normal vital teeth failed to cause inflammatory reaction. Small fragments of normal tooth-structure that became detached from the cut ends of the apices had been healed into the connective tissue without reaction. But each of the ten pulpless teeth set up extensive inflammatory infiltrations, and diplococci were demonstrated in the tissues.

VIII. Papers Read by Title: Abstracts 31–51

31. WHY DENTISTRY HAS FAILED TO BE RECOGNIZED AS "SCIENTIFIC"

Bernhard Wolf Weinberger, D.D.S., F.I.C.D., College of Dentistry, New York University, New York City

Dentistry can be known and appraised, in scientific fields, only through its contact and affiliation with other scientific bodies. Unfortunately the group of recognized research workers in dentistry is very small, and only thirty-one are members of scientific societies, including the American Association for the Advancement of Science. As a result, but five can be found in *American Men of Science*.

In a group of one hundred and nineteen different organizations

[20] Work done at the Mayo Foundation, Rochester, Minnesota; to be published in *Dental Cosmos*.

constituting the American Association for the Advancement of Science, not one represents dentistry or its component societies. This condition, owing entirely to lack of interest, has reacted on the whole profession.[21] When dentists interest and elevate themselves from one group of these societies to another, then to the extent that these memberships increase in number will dentistry become "scientific."

32. A LEAD-SECTOR DISK FOR EXPRESSING DENSITY OF BONE AND TOOTH STRUCTURE IN TERMS OF PERCENTAGE TRANSMISSION OF X-RAYS[22]

Henry Klein, D.D.S., Department of Chemical Hygiene, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

The author described a method in which a lead-sector disk is used as a calibration-disk upon each film to which densities of x-rayed structures are referred. This procedure permits the expression of the densities of the structures in terms of percentage x-ray transmission.

33. STUDIES OF THE ACIDURIC BACTERIA OF THE MOUTH IN RELATION TO SUSCEPTIBILITY AND IMMUNITY TO DENTAL CARIES[23]

Theodor Rosebury, D.D.S., College of Physicians and Surgeons, Columbia University, New York City

Tests for agglutinins and for growth-inhibiting factors in the saliva of caries-free adult human beings and dogs, against dental aciduric bacilli, have resulted negatively in virtually all cases. Three human non-susceptibles and three normal dogs were studied in relation to five strains of aciduric rods isolated from teeth having caries.

The saliva of two of the human cases gave completely negative results for *agglutination* in all tests; that of the third gave a slightly positive reaction with one strain (No. 64), but only when saliva obtained without stimulation was used. Similarly with dog saliva, two

[21] A committee of a national dental society has had affiliations of this type under advisement since March 1929, and hopes soon to bring about one or more of them.—[*Ed.*]

[22] Published in the last preceding issue (April); *Journal of Dental Research*, 1930, x, p. 239.

[23] William J. Gies Fellow in Biological Chemistry at Columbia University. Second appointee, July 1, 1928–January 31, 1930.

specimens from two animals were completely negative or doubtful, while from one the saliva showed agglutination to a dilution of 1–256 with strain No. 64, but none with other strains. Tests for *growth-inhibitory powers* of normal dog sera, and of serum-saliva mixtures, against these five strains, were all definitely negative. One dog (which had given consistently negative results in these tests) yielded a culture of aciduric rods from the mouth in each of five attempts on different days. A careful examination of this dog's mouth disclosed two "developmental" enamel pits and an area of fractured enamel with exposed dentin, all completely free from any carious change. The other dogs and the human cases yielded no aciduric rods in cultures.

An additional fact, disclosed in connection with another investigation now in progress—that every one of forty healthy young albino rats had aciduric bacteria of the Lactobacillus acidophilus type as a normal mouth organism—adds evidence to support the conclusion indicated by this work, namely: immunity and susceptibility to dental caries do not depend, respectively, on the oral presence or absence of an inhibiting factor against organisms of the L. acidophilus type. Whether dental caries may occur in the absence of this particular type has not been indicated by this work, but it is apparent that these organisms may be present in the mouth without giving rise to the condition.

34. RECENT DEVELOPMENTS IN GRAPHIC REGISTRATIONS OF THE MOVEMENTS OF THE HUMAN JAW

George P. Phillips, B.A., D.M.D., Dental School, Harvard University, Boston, Mass.

An attempt to show a possible connection between the muscle coordination manifested by the movements of the human jaws, traced and executed without cusp interference or guidance, and the form of the arch in a given individual.

35. THE GASSERIAN GANGLION IN LUES OF THE CENTRAL NERVOUS SYSTEM

W. R. Pentz, B.Sc., D.D.S., General Hospital, Philadelphia, Pa.

This study included gasserian ganglia from twelve tabetic and paretic subjects, one alcoholic, and ten "normal" cases as controls. In cases of central nervous syphilis there is a marked degenerative change in the second and third roots, which is distinct from the mild degeneration following the ordinary loss of teeth. A similar severe change was found in the roots and ganglion of a case of alcoholic multiple neuritis.

36. ACTINOMYCES AND ACTINOMYCES-LIKE ORGANISMS IN THE PULPS AND PERIDENTAL MEMBRANES OF TEETH[24]

Edward H. Hatton, B.L., M.D., Dental School, Northwestern University, Chicago, Ill.

The current notions with respect to this condition are well stated by Schmidhuber in the *Handwoerterbuch der Gesammten Zahnheilkunde*, and by Kantorowicz and by Lederman in Misch's "*Grenzgebiete.*" According to them, this organism occurs both in pulps that have been freely exposed by caries, and in periodontal infections. The lesions become purulent in character only when pyogenic cocci are associated with the fungus. Calcification of the mixed masses of bacteria and fungus is not uncommon, and is assumed to indicate a healing process.

In the three teeth involved in this report, the organisms were found twice in pulp canals and once in the bifurcation of a molar tooth in a deep pus pocket. Pus and calcification occurred in all three. One of the pulp canals communicated with the periodontal space by a rather wide lateral canal, through which this process spread into the adjacent tissues of the tooth socket. Besides these granules, which resemble actinomyces in all essential respects, there were numerous cocci and bacilli as well as polymorphonuclear leukocytes in these lesions. In all three instances there were no complications following the extraction of the teeth, and healing of the tooth sockets followed the usual course.

[24] To be published in an early issue of the *Journal of Dental Research*.

37. MEDICO-DENTAL CASE RECORDS. VIII. TOXEMIA[25]

Bissell B. Palmer, D.D.S., F.A.C.D., and Malcolm W. Carr, D.D.S., Fifth Avenue Hospital, New York City

The history, progress notes, and follow-up observations in the case reported seem to justify the following conclusions: (1) Oral sepsis may be the dominant etiologic factor in the development of general toxemia. (2) Such toxemia, when not of prolonged duration, and in the presence of a relatively high resistance, may exist without serious organic degenerative changes. (3) The elimination of the primary focus of infection will probably abate, and possibly completely relieve, the secondary symptoms.

38. THE OPERATIVE TECHNIQUE FOR CYSTS OF THE JAWS[26]

Otto Hofer, M.D., Jaw Department, Dental Institute (Director: Prof. Dr. H. Pichler), First Surgical Clinic (Director: Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

The author described the two methods of operation that, with regard to healing, are based (according to Partsch) upon two different principles. In one method (Partsch II)—total extirpation of the cystic membrane—there is scar-formation in place of the cystic cavity. In the *sensu strictiori* Partsch method (Partsch I), there results, after removal of the pressure of the cyst, a gradual flattening of the cavity owing to the effort of the adjacent tissues to fill the original space. The first method is indicated for small cysts surrounded by bone on all sides, where damage to the bone or neighboring teeth, or an involuntary opening into the nasal cavity and the antrum of Highmore, cannot be taken into consideration. For the Partsch-I operation, the following modifications are indicated:

(A) The incision in the mucous membrane, as recommended by Pichler, is made at a great distance from the fixed gingiva, in the vestibulum, and the flap thus attained is used to cover the amputated apices of such teeth as may be involved. In the cyst membrane the

[25] Published in the last preceding issue (April): *Journal of Dental Research*, 1930, x, p. 173. Also reprinted in *Oral Health*, 1930, xx, p. 196; April.

[26] To be published in an early issue of the *Archiv für klinische Chirurgie*.

incision is made close to the alveolar process. By turning this flap upwards, and suturing it to the mucous membrane of the upper cheek, a union between the epithelium of the cyst and the epithelium of the oral cavity is obtained.

(B) In rare cases the epitheliation of the entrance to the cyst is obtained by the introduction of Thiersch's transplantation, and over an obturator formed during the operation, as indicated by the author. This procedure is indicated only for particular cases in which a suture of the cyst membrane is impossible, or where the cyst-lining is necrosed in consequence of inflammation. The procedure according to the method of Partsch seems to be best adapted for most cysts having no connection with the nose and the antrum of Highmore.

Rhinologic methods of operation, in which a communication is made between the antrum of Highmore and the cyst, with subsequent drainage of the common space into the nose (with or without total exfoliation of the epithelial lining of both cavities), seem to be adequate, especially where the cyst is associated with a disease of the antrum of Highmore that necessitates opening into this cavity.

39. HISTOLOGICAL FINDINGS ON THE TEETH OF RATS IN CASES OF EXPERIMENTAL SCURVY[27]

Emerich Kotanyi, M.D., Histological Laboratory (Director: Privatdozent Dr. B. Gottlieb), Dental Institute (Director: Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

White rats were fed a diet lacking vitamin C. The shortest feeding period was four weeks, the longest did not exceed seventeen weeks. The microscopic findings for the dental tissues are characteristic. The localization, as well as the kind, of the ensuing changes are identical with those of scurvy in the guinea-pig. In rats they occur only in the incisors; the molar teeth, having closed root-apices, do not show them. In the dentin they are localized at the incisal edge; in the enamel, at the central or apical part of the tooth. There was a separation of the fibres of the dentin and of the enamel, thereby proving that the albino rat may acquire latent scurvy. The changes in the dentin allow no other explanation than that of humoral origin.

[27] To be published in an early issue of the *Journal of Dental Research*.

40. THE RELATION BETWEEN THE DENTAL LAMINA AND TOOTH GERMS

Balint Orban, M.D., Histological Laboratory (Director: Privatdozent Dr. B. Gottlieb), Dental Institute (Director: Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

In the first stages of development, the tooth-germs are at the end of the dental lamina. After further development, the tooth-germs are found at the side of the lamina; and then the germs separate from the lamina because the latter becomes disintegrated. At a certain stage of development, a second dental lamina appears at each tooth-germ of deciduous teeth. This second lamina is the lateral enamel-strand, as described by Bolk. The appearance of the second lamina is the result of the separation of the germs from the dental lamina. Irregularities may often be seen at the dental lamina. Foldings of it often occur, especially at upper cuspids. In sagittal sections (labio-lingually in front teeth) three dental laminas occur occasionally at upper cuspids, which are caused by several folds in the lamina.

41. HISTOLOGICAL FINDINGS IN THE TEETH AND JAW OF A CHILD TREATED WITH "VIGANTOL" (SYNTHETIC VITAMIN D)

Franz Schönbauer, M.D., Histological Laboratory (Director: Privatdozent Dr. B. Gottlieb), Dental Institute (Director: Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

The author examined microscopically the jaw of a boy, twenty-one months old, who, during a period of one month, received daily twenty-five drops of "Vigantol," and died of pneumonia and pyelonephritis. During the month of treatment, six new teeth erupted. In sections of the teeth, a zone of uncalcified and newly-calcified dentin may be clearly seen. The calcified part of the dentin is broader in the younger teeth than in the older ones. Owing to over-calcification, some odontoblasts were also calcified.

42. DANGERS FOR THE NORMAL OCCLUSION DURING THE SHEDDING OF TEETH

A. Martin Schwarz, M.D., Histological Laboratory (Director: Privatdozent Dr. B. Gottlieb), Dental Institute (Director: Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

If the deciduous teeth do not become ground down, the position of the first permanent molar, after its eruption, is often uncertain ("cusp-to-cusp" bite) until the loss of the deciduous molars. If the upper deciduous molars are lost sooner than the lower, the bicuspids being about 2 mm. narrower than the deciduous molars, the upper first permanent molars shift forward, while the lowers must remain in their places. The result may be a distocclusion of the lower permanent molars. To avoid this danger the lower second deciduous molars should be extracted as soon as the upper ones are lost.

The average mesiodistal diameter of the lower first and second deciduous molars, combined, is about 2 mm. more than that of the upper. In some cases the difference is 4 mm. and more, and the lower second deciduous molar extends distally of the upper, in spite of normal occlusion. When this is the case, the position of the lower first permanent molars must be a distocclusion. To avoid this danger, the lower second deciduous molars should be extracted about one year before the shedding of the upper, and the bite raised.

The sequence of shedding, as well as the size of the teeth, are hereditary factors. Therefore, the secret of the heredity of some malocclusions may be found in simple mechanical processes.

43. CLINICAL SYMPTOMS AND DIAGNOSIS OF THE OSTEODYSTROPHIA (OSTEITIS) FIBROSA LOCALISATA OF THE JAWS[28]

Karl Spring, M.D., Jaw Department, Dental Institute (Director: Prof. Dr. H. Pichler), First Surgical Clinic (Director: Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

Although during the past few years *Osteodystrophia fibrosa localisata* (*o.f.l.*) of different bones has been the subject of numerous clinical and

[28] Published in the *Deutsche Zahnheilkunde* (1929, Heft 75, p. 18). A translation, by Dr. S. E. Michlin of New York, will appear in the *Dental Outlook*.

roentgen-ray investigations, very few case histories of *o.f.l.* of the jaws have been presented. Therefore a summary of our knowledge of this disease is desirable.

From a *pathologic anatomical point of view*, *o.f.l.* is a proliferation of bone-marrow, beginning in the interior of the bone and expanding to the surface. It is called "brown tumor" because of its more or less brown color. Histologically these proliferations are an extremely vascular tissue composed of spindle- and giant-cells. It is now generally agreed that this disease is not a malignant tumor, nor a sarcoma.

Clinically, *o.f.l.* of the jaw has exactly the same appearance as a central bone-tumor of a long bone. In differential diagnosis of cases in *long bones*, only central bone-sarcoma need be considered. But the number of tumors with which *o.f.l.* of the *jaw* may be confounded is great, and one must always think of tumors originating from tooth germs, teeth, and their surrounding tissues (follicular and radicular cysts, adamantinoma, odontoma, and inflammatory processes). Clinically a differential diagnosis is usually impossible. The advanced forms of *o.f.l.* of the jaws show the same symptoms as maxillary cysts: fluctuation and egg-shell crackling. Puncture and injection with jodipine solution, and subsequent roentgen examination of the diseased area, which clinically appears as a cyst, are valuable aids in a differential diagnosis, because pathologically most of these cases are pseudocysts, which, after a jodipine filling, naturally present a picture that is different from those of real cysts of the dental group.

Roentgen diagnosis. Because of its purely expansive growth, *o.f.l.*, like maxillary cysts, makes the surrounding bone hollow. Therefore *o.f.l.* shows the same roentgen symptoms as a cyst of dental origin. A roentgen plate of *o.f.l.* of a jaw appears like a multilocular cyst (adamantinoma), from which it can be differentiated in only a few cases, while differentiation from a dental cyst is usually easy.

In *differential diagnosis*, both clinically and by roentgen rays, genuine central bone-sarcoma must be taken into consideration, but only if growing rapidly. Where there are no characteristic roentgen-ray findings (lamellar boundary, no break in the cortical layer), differentiation may be impossible. In such cases a definite diagnosis can be made only by exploratory excision.

44. EXPERIMENTAL STUDY ON THE TEETH OF RICKETY RATS FED "VIGANTOL"

Josef Weinmann, M.D., Histological Laboratory (Director: Privatdozent Dr. B. Gottlieb), Dental Institute (Director: Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

The incisors of a rat grow continuously during the life of the animal. By studying such teeth microscopically, the state of the calcium metabolism can be ascertained. Two litters of white rats of the same age, all suffering from rickets, were daily fed "Vigantol" (synthetic vitamin D). Two rats were killed daily. In this way the healing effect of "Vigantol" in rickets may be studied.

In the dentin of the incisor of a rickety rat, fed once with "Vigantol" and killed the next day, there was only a thin layer of calcified dentin—the outer layer (cover dentin). This layer is always calcified, even in the worst disturbances of calcification. Toward the pulp there was a broad layer of uncalcified dentin. After *three feedings*, this aspect was changed. In the central (apical) part of the tooth there were dark-blue calcium globuli in the formerly-uncalcified layer. In the middle portions, the formerly-uncalcified parts were reduced. Also in the peripheral regions there was a remarkable improvement.

After *seven days of feeding*, the formerly-uncalcified dentin of the central part was well calcified, and only a thin layer was uncalcified. In the middle portion, beneath the always-well-calcified cover-dentin, there was a rickety globular zone. Adjacent to it there was a regularly calcified layer, with an uncalcified margin of normal width. In the peripheral portions, the same conditions prevailed. The rickety globular-zone, towards the pulp, was covered by a layer showing deep staining, a sign of over-calcification. After *nine days of feeding*, the central portions were normal in the calcification of the dentin. A regularly calcified, broad layer of dentin was limited by a thin margin of uncalcified dentin. In the middle and peripheral portions one observed the dentin layer with extremely small interglobular spaces, which pulp-wise was covered by a layer showing remarkably good calcification.

45. THE INDICATIONS FOR SURGICAL TREATMENT IN INFLAMMATORY DISEASES OF THE JAWS ARISING FROM THE TEETH

Hermann Wolf, M.D., Jaw Department, Dental Institute (Director: Prof. Dr. H. Pichler), First Surgical Clinic (Director: Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

Inflammatory diseases about the jaws, arising from the teeth, begin in two ways: (1) at the apex of the tooth (periapical infections), and (2) in the gums and other tissues surrounding the tooth (paradontal infections; periodontoclasia). Diseases arising from the apex can come only from a pulpless tooth, but paradontal diseases may be associated with a living tooth as well as a pulpless one. Each kind may lead to formation of an abscess, different degrees of osteomyelitis, ostitis, and phlegmon (cellulitis) of soft tissues. The latter is the cause of a majority of larger operations, because ostitis, apart from sequestrotomia, should be treated conservatively as a rule. In the *lower* jaw there may be (a) phlegmon (perimandibular phlegmon), inflammation of the soft parts in the floor of the mouth (angina Ludovici), and spreading of pus to the *glandula submaxillaris* and *sublingualis*. (b) Inflammations about the *ramus ascendens* arise from infected teeth not only in the lower jaw, but also in the upper, and lead in some cases to temporal phlegmon, and abscess formation under the temporal fascia; in other cases, to *phlegmonous retrobulbaris*, thrombosis of the *sinus cavernosus*, meningitis. Complications of inflammation arising from infected *upper* teeth are (a) *empyema antri maxillaris*, *phlegmonous retrobulbaris*, thrombosis of the *sinus cavernosus*. (b) As the lymph from the teeth, upper as well as lower, is collected by the *glandulae lymphaticae submandibulares*, suppuration of these glands may occur in the presence of any such phlegmon.

While the above-named inflammations may arise from periapical infection of any tooth, paradontal infections hardly ever give rise to such serious complications, with one exception: pocket infections about lower third molars. The operations to be used in order to stop these processes, apart from early opening of the tooth, are these: (1) extraction of the tooth; (2) intraoral incision; (3) intraoral incision, connected with the bone trepanation (drilling open the spongiosa cells); and (4) extraoral incision. Further, in cases of specially severe

inflammations of the upper jaw, (5) resection of the facial side of the antrum maxillary sinus; (6) radical operation of the maxillary empyema; (7) resection of the floor of the orbita from the opened *antrum maxillare* (method of Bleichsteiner); (8) opening of the cavity retrobulbaris by Krönlein procedure (osteoplastic opening of the orbita from the outside); and (9) exenteration of the orbita. As a rule the operation should be made under general narcosis. In some cases (very difficult extractions, for instance) one may also resort to conductive anesthesia, at a great distance from the inflamed part (for example, at the *foramen ovale*). Preservation of the tooth should be considered only in simple cases.

We do not always extract the tooth before the incision of the phlegmon. If there is no lockjaw, the sequence of the operations is immaterial. But in lockjaw cases, an increase of pressure in the abscess might result from forcible separation of the jaws. Then it is much better first to remove the pus by incision. In treating inflammations of the lower jaw, the extraoral incision affords a better drainage than the intraoral, which is sufficient only in minor cases or in certain phlegmons of the *ramus ascendens*. As the conditions for drainage are more favorable for infections about the upper jaw, extraoral incisions are exceptions in such cases—luckily, on account of the branches of the facial nerve. In incisions about the margin of the lower jaw, the *ramus marginalis* of the *nervus facialis* may be endangered. Therefore, the incision should be made three-finger breadths from the lower margin of the horizontal part of the jaw, which is not too much considering the existent swelling and stretching of the tissue. For cosmetic reasons the incision should be made in a fold in the neck. The above-mentioned bone operations on the upper jaw (5–8), and the *exenteratio orbitae* are very seldom resorted to, but they may sometimes save the life of the patient, if made before it is too late. But it is a difficult matter for the surgeon to make up his mind to demand from a patient the sacrifice of an eye.

46. SENSITIVE APPARATUS FOR MEASURING EXPANSION IN DENTAL PLASTERS AND INVESTMENTS

S. G. Ritchie, B.A., D.M.D., Dental School, Dalhousie University, Halifax, N. S.

This apparatus is one of several designed and constructed for use in an investigation of the physical properties of dental plasters. It consists of a rectangular steel base, 60 x 20 x 1 cm., supported by three leveling screws. Two parallel polished steel strips, 13 cm. apart, are screwed to the base near the back. A specially prepared microscope-foot slides easily along them, and can be locked at any desired position. The microscope is turned down so that the stage is in a vertical plane. Two adjustable brass standards, 5 cm. from center to center, are placed in line near the front at the left end of the base, so that a straight line through their centers would pass parallel to and just in front of the microscope stage. The standard nearest the left end carries a table 5 cm. in diameter, which supports the plaster cup. The other standard supports a cross piece that acts as a fulcrum for the lever, which is 30 cm. long and rests on three steel pins, two of which are spaced 5 cm. apart on the fulcrum, while the third forms the apex of an isosceles triangle, and rests on the center of the cover-glass placed over the plaster in the cup, the distance from point to fulcrum being 5 cm. The lever, therefore, is in the ratio of 5 to 1. To the end of the long arm of the lever, a filament of glass is attached, on which readings are taken when the microscope is properly adjusted. The plaster cup is cylindrical in shape, 25 mm. in diameter and 25 mm. deep, highly polished inside, and so constructed that the set-plaster can be readily removed.

The lever can be adjusted and a reading taken in from ten to fifteen seconds. A stage-micrometer in conjunction with an adjustable eyepiece-micrometer makes the calculation of actual linear and volume expansion easy, although the amount of plaster used is small. The apparatus is located on a shelf attached to a brick wall in the basement of the Dental School. The lever action is so sensitive that walking across an upper floor causes the glass filament to oscillate violently in the microscope field.

47. DENTAL MORPHOLOGY AND PATHOLOGY OF PREHISTORIC GUAM[39]

R. W. Leigh, B.A., D.D.S., M.A., Bernice P. Bishop Museum, Honolulu, Hawaii

Somatological features of note are the streaming of enamel toward bifurcations, particularly of the inferior second and third molars, terminating in an acute point; corrugation of the enamel on the facial aspect of the superior premolars and molars; marginal ridges on the superior incisors in moderate degree in 20 percent of the skulls; and a cusp formula which tends to be $\frac{4-4-4}{5-4-4}$. The inferior first molar is constant; the inferior second molar is quadricuspid in 80 percent; the superior third molar is very variable. Such a cusp formula is not indicative of a primitive race. The superior third molar in many cases is vestigial. Some males have large angular jaws, and large teeth with accessory roots. The palate is short, broad, and roundish; 95 percent are brachyuranic. The average dental index is 42.6; the group tends to be mesodont. The average gnathic index is 98.9; thus the group is mesognathous. In many crania, particularly females, there is a sub-nasal prognathism: the incisors are somewhat procumbent with an end-to-end occlusion and fullness of the oral region. There are marked sexual differences, otherwise homogeneity characterizes the group, probably resultant from inbreeding. The somatology is unmistakably Mongoloid.

Ancient Guam subsisted exclusively upon the flora and fauna of their insular habitat: fish, fowl, bread-fruit, taro, yams, rice, bananas, coconuts. As throughout the tropical Pacific, they cooked in pits in the earth with heated stones.

Betel nut was the narcotic to which they were strongly addicted, which is a cultural trait of wide Oriental distribution. The nut used is from the betel palm, *Areca catechu*. A part of the nut is wrapped with a few leaves of betel pepper, *Piper betle*, and the whole sprinkled with a pinch of lime, the latter secured by burning coral. The betel juice produces a soluble red pigment that colors the saliva, lips, and mouth a rich red, and gradually but permanently discolors the enamel, particularly on the facial surfaces. The quid is habitually held in

[39] To be published in the next issue of the *Journal of Dental Research*.

the buccal recess. Heavy lime accretions were deposited upon the teeth with resultant pathological processes. This habit, and the soft diet requiring but little mastication, were the primary factors in producing a high incidence of chronic degeneration of the investing tissues. All females and 65 per cent of males beyond forty had teeth affected by periodontal disease—third molars most frequently. No person under thirty had lost any teeth at decease; periodontoclasia was the major cause of loss in later life. Dental caries, mostly of senile type, occurs in 18 percent. Sixteen percent evidence periapical lesions secondary to caries, attrition, and fracture. Impacted lower third molars caused extensive disturbance. Serious lesions of the palate and nose of some individuals evidently resulted from yaws.

Ethnic deformation was practised to a limited extent by filing a lattice design on the facial surfaces of the superior six anterior teeth. Staining the teeth an orange to black color was customary.

48. ODONTOCLASIA: A CLINICALLY UNRECOGNIZED FORM OF TOOTH DECAY IN THE PRE-SCHOOL CHILD OF HONOLULU[30]

Martha R. Jones, Ph.D., Nils P. Larsen, M.D., and George P. Pritchard, D.D.S., Research Department of the Queen's Hospital, with the coöperation of the Palama Settlement Dental Clinic, and the University of Hawaii, Honolulu, Hawaii

Detailed dental examinations were made on 1761 pre-school children of the various races resident in Honolulu. This number included approximately 80 percent of all children enrolled in baby clinics and free kindergartens, and a like percentage of those in certain selected private schools. A type of decay simulating in great detail that described by Simonton and Jones,[31] and called by them "odontoclasia," was found to be prevalent in the deciduous teeth of children of all races in the poorer districts. The lesion differs from dental caries in its location, mode of progress, and age incidence. Prenatal and possibly early environmental faults appear to play an important rôle in this type of decay. For diagnostic purposes we have designated the lesion odontoclasia.

[30] To be published in *Dental Cosmos* as the first of a series of four related papers.

[31] Simonton, F. V., and Jones, M. R.: *Journal of the American Dental Association*, 1927, xiv, p. 984.

Race incidence of odontoclasia and caries in 1283 kindergarten children. Of 1005 Orientals examined, 81.9 percent had odontoclasia; 92.0 percent, caries; 0.7 percent, no decay. In the group of 55 Hawaiians, 56.3 percent had odontoclasia; 92.7 percent, caries; 1.8 percent, no decay. The 109 Caucasian children represented the highest social strata in the city. Of these, 8.2 percent had odontoclasia in mild form; 52.3 percent, caries; 46.8 percent, no decay.

Age incidence of odontoclasia and caries in 1610 children, 6 months to 6.5 years of age (Caucasians excluded). Roentgenograms of the upper anterior teeth (the most susceptible to odontoclasia) showed no evidence of decay prior to eruption, although disintegration of both labial and lingual surfaces frequently starts almost immediately after teeth are through the gums. Twelve of the 36 children under one year of age, with four or more erupted teeth, had odontoclasia; none had caries. The incidence of odontoclasia reached a peak in the 3-year old child, 78.4 percent of 102 children examined, and 76.9 percent of the kindergarten group (1174), having the lesion. Caries began between one and two years of age, and increased in incidence from 13.3 percent in this group to 91.5 percent of the kindergarten children.

The oral condition of the different individuals with odontoclasia varied greatly. In some instances only a few teeth were involved, usually the upper anteriors; in others, all were more or less disintegrated. In many babies twelve to eighteen months of age, decay was exceedingly active, the crowns of all erupted teeth having been denuded of enamel in a few weeks. The process might then be arrested and no further decay occur, even though the partially disintegrated enamel and dentin were deeply infiltrated with bacteria and organic material. Ninety percent of the babies under one year of age were essentially breast fed, and their average weights at the various ages closely approximate the Baldwin-Wood standards. Not one had stigmata that would warrant a diagnosis of rickets, although there was evidence of subnormal bone development. The enamel of the teeth was almost universally soft, and could be easily scratched with an explorer.

Odontoclasia is primarily a systemic disorder, and occurs concomitantly with rapid calcification of the long bones. It is not associated with rickets, malnutrition, or any other known disease.

49. OFFENSIVE BREATH, ITS CAUSES AND ITS PREVENTION[32]

Hermann Prinz, D.D.S., M.D., Pharmacologic Laboratory, School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

In the introduction the nature of the subject is stated, followed by a short résumé of the physiology of olfaction. The nomenclature and review of international literature are followed by the pathology of offensive breath, which is discussed from the view-point of etiology and sub-divided into *causes arising from* (1) purely dental conditions, i.e., teeth, artificial dental substitutes, and gingival tissues; (2) diseases of soft structures of the oral cavity; (3) diseases of the naso-pharyngeal region; (4) digestive tract; (5) broncho-pulmonary diseases; (6) certain metabolic, infectious, febrile, and genito-urinary diseases; (7) absorbed drugs or poisons; (8) foods, condiments, and stimulants. The closing paragraphs contain suggestions in regard to prophylactic measures and treatment, and are followed by a bibliography containing twenty-one references.

50. SPACING OF CALCIFICATION CENTERS DURING TOOTH DEVELOPMENT

John H. Swanson, A.B., M.S., Laboratory of Histology and Embryology, Western Reserve University, Cleveland, Ohio

According to certain text-books the distance between the cusps increases, before fusion, to more than quadruple that found at the inception of calcification. Since radiographic records do not bear out this view, serial sections of fetal jaws of pig and man are being measured to explain the discrepancy. The results to date substantiate the view that increase in intercuspal distance occurs, but show that its extent is materially less than heretofore reported.

51. A FURTHER STUDY OF THE MUCOID IN TEETH

William J. Gies, Ph.D., Laboratory of Biological Chemistry, School of Medicine, Columbia University, New York City

In the initial study of dentomucoid, this protein was found in dog

[32] To be published in *Dental Cosmos*.

cuspid teeth from which all external soft tissue had been mechanically removed.[33] In a resumption of the study on miscellaneous human teeth by the previous procedure, which included decalcification of pulverized teeth with 2 percent acetic acid by dialysis in small collodion bags, extraction of the residue with half-saturated lime-water, and precipitation with 2 percent acetic acid, the original general results were confirmed. As the first step in an effort to determine the distribution of dentomucoid, several preparations of enamel from human teeth have been subjected to the test for this protein. For one of these specimens I am greatly indebted to Dr. Theodor Rosebury, who prepared it by the chiselling method recently described by him.[34]

After decalcification of the enamel powder by the procedure indicated above, the insoluble matter from each specimen was found to be completely free from protein that could be extracted with half-saturated lime-water.[35] This consistently negative result demonstrated the absence not only of mucoid but also of nucleoprotein.[36] These findings agree with Rosebury's conclusion that keratin is the only protein in enamel.[37] An extension of the study will include separate examinations of pericementum, dentin, and pulp.

IX. Papers Read by Title: Abstracts not Available (52–54)

52. Results of three years of cultural control of a root-canal technique. *James P. Pigott, D.D.S., Medical School, Yale University, New Haven, Conn.*

53. Dental findings in pre-school Polynesian, Japanese, and Filipino

[33] Gies and collaborators: *Proceedings of the Society for Experimental Biology and Medicine*, 1917, xv, p. 5; reprinted in the *Journal of Dental Research*, 1930, x, p. 218.

[34] Rosebury: *Journal of Dental Research*, 1930, x, p. 187.

[35] This was determined with the writer's reagent for the biuret test. By the same means, the filtered liquid within the bags was also found to be free from protein matter, a result that confirms similar findings by Rosebury: *Loc. cit.*, p. 195.

[36] In the acid-decalcification process, proteins that are not wholly soluble in 2 percent acetic acid would be represented in the particles in the bag. As there are no cell nuclei in enamel, the presence of nucleoprotein could not have been expected.

[37] Rosebury: *Loc. cit.*, p. 211. The organic residue from the enamel (keratin), which was indigestible in pepsin-HCl and trypsin-Na_2CO_3 solutions, and gave the lead test for loosely-bound sulphur—in accord with Rosebury's findings—also became deep blue in a dilute solution of trypan blue. The connection between this result and earlier observations (Gies and collaborators: *loc. cit.*) will be indicated in a future communication.

children in rural districts on the Island of Oahu.[38] *Martha R. Jones, Ph.D., Nils P. Larsen, M.D., and George P. Pritchard, D.D.S., Queen's Hospital, Palama Settlement Dental Clinic, and University of Hawaii, Honolulu.*

54. Factors in dental decay of pre-school children of certain races resident in Honolulu and rural Oahu.[38] *Martha R. Jones, Ph.D., Nils P. Larsen, M.D., and George P. Pritchard, D.D.S., Queen's Hospital, Palama Settlement Dental Clinic, and University of Hawaii, Honolulu.*

X. Titles of Papers Transferred to the Program of a Special Meeting of the New York Section[39]

The occurrence of mottled enamel among the Chinese. *Bert G. Anderson, D.D.S., and Paul H. Stevenson, M.A., M.D., Peiping Union Medical College, Peiping, China*

Calcification of teeth and bones on rachitic and non-rachitic diets. *Maxwell Karshan, M.A., Ph.D., School of Medicine, Columbia University, New York City*

The present status of the investigation of the cause and the geographical distribution of mottled enamel. *Frederick S. McKay, D.D.S., New York City*

Primary mouth manifestations of skin diseases. *Joseph Schroff, M.D., D.D.S., Dental School, Columbia University, New York City.*

XI. Data of Executive Proceedings

A. Lists of the officers, and new members, elected[40]

a. Officers (1930–31)

President—U. G. Rickert, University of Michigan. *President-elect*—A. E. Webster, University of Toronto. *Vice-president*—R. W. Bunt-

[38] To be published in *Dental Cosmos.*

[39] For abstracts, see the proceedings of the New York Section of the International Association for Dental Research, in this issue: *Journal of Dental Research,* 1930, x, p. 265.

[40] Lists of the officers and members, as of December 1, 1929, were published in the *Journal of Dental Research,* 1929, ix, p. 758.

ing, University of Michigan. *Treasurer*—William Rice, Tufts College. *Secretary*—William J. Gies, Columbia University.

b. New members[41]

Albuquerque, New Mexico

Howard R. Raper, D.D.S., F.A.C.D., 1516 E. Silver Ave.

Baltimore, Md.

Henry Klein, D.D.S., Sc.D., Research Fellow, School of Hygiene and Public Health, Johns Hopkins University

Boston, Mass.

Francis H. Daley, D.M.D., Instructor in Clinical Pathology, Dental School, Tufts College

Cleveland, Ohio

Thomas J. Hill, D.D.S., Professor of Clinical Oral Pathology and Therapeutics, Dental School, Western Reserve University

Victor C. Myers, B.A., M.A., Ph.D., Professor of Biochemistry, Western Reserve University

Germany (Berlin, Cologne, Greifswald)

Wilhelm Dieck, M.D., D.M.D., Sc.D., Dean, Dental School, University of Berlin

Friedrich Proell, M.D., Professor, Medical School, University of Greifswald

Rudolf Weber, M.D., D.M.D., Chief, Dental Clinic, Cologne

Honolulu, Hawaii

Martha R. Jones, B.S., M.A., Ph.D., Research Associate, Queen's Hospital

R. Wood Leigh, B.A., D.D.S., M.A., Dental Surgeon, U. S. Army, Tripler Hospital

Iowa City, Iowa

Charles L. Drain, D.D.S., Associate Professor of Preventive Dentistry and Pedodontia, Dental School, State University of Iowa

London, England

Arthur Bulleid, L.R.C.P., M.R.C.S., L.D.S., Assistant Bacteriologist, Guy's Hospital

[41] Since the adjournment of the Toronto meeting new sections of the Research Association have been organized in Cleveland, Ohio; London, England; New Haven, Conn.; Washington, D. C.; and Winnipeg, Manitoba.

Frank Colyer, K.B.E., F.R.C.S., L.D.S., Curator, Odontological Museum, Royal College of Surgeons of England

Frederic N. Doubleday, L.R.C.P., M.R.C.S., L.D.S., Dental Surgeon, Guy's Hospital

Eric W. Fish, M.D., Ch.B., L.D.S., Assistant Dental Surgeon, Royal Dental Hospital and School of Dental Surgery of London

Evelyn Sprawson, L.R.C.P., M.R.C.S., L.D.S., Director of Dental Studies, London Hospital Dental School

Joseph G. Turner, F.R.C.S., L.R.C.P., L.D.S., 59 Wimpole St. W.

Minneapolis, Minn.

Harold G. Worman, Instructor, Dental School, University of Minnesota

New Haven, Conn.

Caspar G. Burn, C.P.H., Instructor in Pathology, Medical School, Yale University

Albert M. Crosby, D.D.S., Clinical Instructor in Dental Surgery, Medical School, Yale University

Raymond G. Hussey, M.D., M.A., Professor of Pathology, Medical School, Yale University

James P. Pigott, D.D.S., Attending Oral Surgeon, New Haven Hospital

George H. Smith, B.A., M.A., Ph.D., M.A. (Hon-Yale), Professor of Immunology, Medical School, Yale University

New York City, N. Y.

Bert G. Anderson, D.D.S., Associate Professor of Dentistry, Dental School, Columbia University

Edmund Applebaum, D.D.S., Instructor in Dental Histology and Embryology, Dental School, Columbia University

Sigmund W. A. Franken, D.D.S., Attending Dentist, Lenox Hill Hospital

Theodor Rosebury, D.D.S., Instructor in Bacteriology, Medical School, Columbia University

Joseph Schroff, B.S., M.D., D.D.S., Associate Professor of Oral Pathology, Dental School, Columbia University

Philadelphia, Pa.

Thomas J. Cook, D.D.S., Assistant Professor of Oral Diagnosis, Dental School, University of Pennsylvania.

St. Louis, Mo.

Wesley A. Chamberlain, D.D.S., President, St. Louis Dental Society, Metropolitan Building

Edgar H. Keys, D.D.S., Member, Missouri State Board of Dental Examiners, University Club Building

Russell C. Wheeler, D.D.S., Instructor in Crown-and-Bridge Work and Porcelain Art, Dental School, Washington University

Jesse D. White, D.D.S., F.A.C.D., Professor of Crown-and-Bridge Work and Porcelain Art, Dental School, Washington University

Toronto, Canada

George W. Grieve, L.D.S., D.D.S., 2 Bloor St., East

Robert J. Reade, L.D.S., D.D.S., M.D., M.A., C.M., Chairman, Public Dental Health Committee, Ontario Dental Association, King Edward Hotel

Vienna, Austria

Arved Berg, M.D., Assistant, Jaw Clinic, General Hospital

Karl Breitner, M.D., Ebendorfer Str. 10, I

Fritz Driak, M.D., Demonstrator, Dental School, University of Vienna

Richard Grohs, M.D., Assistant, Dental School, University of Vienna

Otto Hofer, M.D., Assistant, Jaw Clinic, General Hospital

Hans Pichler, M.D., Director, Dental School, University of Vienna

Otto Preisecker, M.D., Assistant, Dental School, University of Vienna

Franz Schönbauer, M.D., Demonstrator, Dental School, University of Vienna

Harry Sicher, M.D., Privatdozent, University of Vienna

Karl Spring, M.D., Assistant, Jaw Clinic, General Hospital

Richard Trauner, M.D., Assistant, Jaw Clinic, General Hospital

Washington, D. C.

Arthur B. Crane, D.D.S., 706 The Farragut

Robert A. Keilty, M.D., Consultant Pathologist, United States Veterans Bureau, Diagnostic Center

Wilmer Souder, Ph.D., Chief, Dental Laboratory, National Bureau of Standards

Winnipeg, Canada

E. Roy Bier, L.D.S., D.D.C., D.D.S., Research Committee, Canadian Dental Association, 549 Somerset Building

Fred T. Cadham, B.A., M.D.,F.A.C.P., Professor of Bacteriology, Medical School, University of Manitoba

Matthew H. Garvin, L.D.S., D.D.S., President, Canadian Dental Association, 314 Somerset Building

Kenneth M. Johnson, L.D.S., D.D.S., D.D.C., 314 Somerset Building

Anne G. E. Mackenzie, B.A., D.D.S., Dentist-in-Charge, General Hospital

Howard J. Merkeley, L.D.S., D.D.S., M.D.S., D.D.C., 611 Medical Arts Building

Warren J. Riley, L.D.S., D.D.S., D.D.C., Secretary, Winnipeg Dental Society, 502 Medical Arts Building

Total number of new members, 56

Total membership (May 24, 1930), 229

B. NAMES OF MEMBERS PRESENT AT ONE OR MORE SESSIONS

(Arranged in sectional groups)

Ann Arbor.—Bunting, Rickert, Ward. *Boston.*—Daley, Hatch, Miner, Morse (F.W.), Rice, Wright. *Chicago.*—Coolidge, Hatton, Kronfeld, Noyes. *Halifax.*—Bagnall, Thomson, Young. *Minnesota.*—Waldron. *New York.*—Bödecker, Dunning (W.B.), Gies, Hirschfeld, McCall, Owre, Waugh. *Philadelphia.*—Appleton, Cook, Downs, Ivy. *Pittsburgh.*—Dewey, Friesell (H.E.), Wright. *Toronto.*—Adams, Box, Broughton, Cowling, Cummer, Ellis, Grieve, Husband, McDonagh, Paul, Reade, Trotter, Webster. *Not yet members of a section.*—Bryan, Chase, Hill, Pigott. Total—48.

At each scientific session there was a large attendance of visitors, many of whom, as members of dental faculties, also attended the coördinated sessions of the American Association of Dental Schools.[42]

[42] See the footnote on page 367.

Quotations Relating to "Dentistry or Stomatology"

THIS JOURNAL uses the term "dentistry" to signify the science and art of oral health service in all its local and systemic relationships. The meanings of words, which are not necessarily restricted to *etymological* significance, acquire expanded or new import in accordance with convenience and usage. Thus the term "medicine," which originally meant to remedy or cure, now also means *to make remedial or curative treatment unnecessary.* "Stomatology" is a synonym for "dentistry." We prefer the older term because its use respects both the history of dentistry and the efforts of those who have brought dentistry to its present status.—*Journal of Dental Research*, 1929, ix, p. iii.

If dentistry were merely dental mechanics, a two-year course in dental technology, based on graduation from a high school and conducted along lines similar to those for the education of optometrists, would probably afford sufficient training for dental practice, and oral health-service could be reserved for a new specialty to include oral surgery, which might be named stomatology and made analogous to ophthalmology and other specialties of medicine. But with dentistry developed into the *full service equivalence* of an oral specialty of medicine, the creation of a medical specialty of stomatology would be redundant—and there would be no occasion to substitute "stomatology" for the name established by custom.—*Carnegie Foundation's Bulletin on Dental Education*, 1926, p. 135.

The assumption that dentistry would be something more or better than it is, if all or a part of it were called "stomatology," exemplifies a readiness to attach more importance to labels than to contents, or more significance to make-believe than to reality. The term "medicine" originally meant to remedy or cure. ["*Medicina* (ars)"—healing art; "*medicina* (res)"—a remedy; "*medicus*"—of healing; also a physician.] Today "medicine," by including measures to *prevent* sickness and by throwing *etymology* overboard, means not only to remedy or cure, but also *quite the contrary*—to make remedial or curative treatment unnecessary. As medical knowledge has advanced and medical procedures have been changed in consonance, including the development of prevention and of surgery, new meanings have been imparted to the term "medicine." But instead of replacing "medicine" by a succession of words intended to indicate *etymologically* the broader or deeper modern meanings, the import of the original term has been conveniently enlarged as the scope of medical practice has expanded. Thus, the term "medicine" has come to mean more and more as *physicians*, without restricting themselves to its *etymology*, have included *more and more in its significance.* Along the same line of reasoning one sees clearly that, although *etymologically* the term "dentistry" refers only to the teeth, nevertheless logically it also comprehends the contiguous parts and their systemic relationships. Certainly by *usage* in conformity with this logic, and also with the criteria of common sense, the term "dentistry" has *acquired* the broader meaning suggested by the more detailed and lengthy term "oral health-service." By logic, usage, and convenience, the term "dentistry" has thus become the *practical* equivalent of "stomatology," which *etymologically* means the sum of scientific knowledge concerning the mouth, but *etymologically does not include the rest of the body* (although "stomatology" is now *used* by some to include systemic relationships with the mouth). This being true, we are unable to agree that "dentistry" and "dentists," which are terms that have long represented the earnest and aspiring endeavors of generations of faithful practitioners of oral health-service, should be formally replaced for *etymological* reasons by "stomatology" and "stomatologists."—*American College of Dentists*, March, 1929.

The New York Academy of Dentistry . . . without any diminution of its abiding purpose to promote intimate association and cooperation between dentists and the practitioners of all other kinds of health-service, believes that, in the interest of the patient, dentistry should be *continued* as a separately organized profession, based on systems of ethics, education, jurisprudence, and journalism that will fully meet all public needs at each stage of its evolution.—*New York Academy of Dentistry, April, 1929.*

The Dental Society of the State of New York . . . expresses the earnest conviction . . . that the most effectual development of oral health-service will be insured by the *continuance* of dentistry as a separately organized profession . . . [and] also records its unabated desire and intention to promote personal and professional accord, cooperation, and mutual helpfulness between dentists and the practitioners of medicine and all other kinds of health-service.—*Dental Society of the State of New York, May, 1929.*

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Meetings in 1929–30

SECTIONS. *Ann Arbor:* May 22. *Boston:* November 5, February 3, May 27. *Cleveland:* May 14. *Chicago:* December 16, February 26, May 8. *Halifax:* October 21, May 2. *New Haven:* March 29. *New York:* December 5, March 13. *Philadelphia:* October 30, November 13. *Pittsburgh:* November 4, December 2, January 6, February 3, March 3, April 7, May 5, June 2. *San Francisco:* October 4. *St. Louis:* September 12, October 10, November 14, December 12, January 9, February 13, March 13, April 10. May 8, June 12. *Toronto:* October 2, January 7, February 20. *Vienna:* September 21. *Winnipeg:* April 23.

ASSOCIATION: *Eighth general meeting,* Toronto, March 24–26, 1930.

All persons interested in dental research are invited to attend the scientific meetings of the Sections and of the Association.

INFORMATION FOR PROSPECTIVE SUBSCRIBERS OR CONTRIBUTORS

THE JOURNAL OF DENTAL RESEARCH is dedicated to the advancement of research, and to the dissemination of knowledge, pertaining to the teeth and mouth and to their relations to the body as a whole. It publishes original investigations and reviews in these fields, and in the sciences allied with or applied to them. Issued bi-monthly, at the *ends* of the months of February, April, June, August, October and December, each volume contains at least 600 pages, for which the subscription price is $5.00.

This JOURNAL is the official publication medium of the dental organizations named on the title page of this cover. Although without a "policy," the JOURNAL represents an unwavering purpose to keep widely open the channel to freedom of *responsible* and *respectable* expression of truth and opinion, by individuals or organizations, without qualification by or for any views its editors individually may entertain. In accordance with this purpose, papers contributed by societies are controlled and edited by the respective associations through their official representatives.

THE JOURNAL OF DENTAL RESEARCH circulates widely among the most enlightened and progressive dentists and physicians, and among the leading libraries, thus assuring the degree and quality of publicity for its contents that the best dental literature merits. Therefore there can be no important occasion, except in very special instances, for the detailed presentation elsewhere of a paper published in this JOURNAL. Accordingly, to prevent waste of the JOURNAL's resources in needless duplicate publication, and also to lighten the labors of students of the literature of dentistry, papers in this JOURNAL are not published in, or reprinted from, other dental journals, except for unusual professional reasons.

Authors of papers *on original research* will receive, free of charge, 50 reprints of their papers, *if they indicate their desires before the issue containing them goes to press.* Copies in any number may be obtained at prices that will be quoted on request.

Address all communications relating to editorial matters to the JOURNAL OF DENTAL RESEARCH, 632 West 168th Street, New York City; business communications, to the JOURNAL OF DENTAL RESEARCH, Mount Royal and Guilford Avenues, Baltimore, Md.

CONTENTS

June, 1930

International Association for Dental Research. Scientific proceedings of the Chicago Section. *Stanley D. Tylman,* B.S., D.D.S., F.A.C.D., *Editor* 247

Some uses for dissolved celluloid in the preparation of ground sections of bones and teeth. *Samuel W. Chase,* Ph.D. 251

The prevention of caries and periodontoclasia. *Paul R. Stillman,* D.D.S., F.A.C.D., F.A.A.P., and *John Oppie McCall,* A.B., D.D.S., F.A.C.D., F.A.A.P. 255

International Association for Dental Research. Scientific proceedings of the New York Section. *Bissell B. Palmer,* D.D.S., F.A.C.D., *Editor* 265

Research in the use of a rating scale as a means of evaluating the personalities of senior dental students. *R. K. Brown,* M.S., D.D.S. 271

Studies on inorganic salt metabolism. V. The effect of faulty diet on the dentition of brood bitches, and the dental and skeletal development of their offspring. *Martha R. Jones,* Ph.D. 281

Concerning defects in the enamel of teeth of ancient American Indians. *Charles F. Bödecker,* D.D.S., F.A.C.D. 313

The epithelium in dental granulomata. *Thomas J. Hill,* D.D.S. 323

Notes on the neuro-histology of the pulp of a hypersensitive tooth. *Lester Richard Cahn,* D.D.S. 333

Clinical oral surgery, with special emphasis on its related pathology: Part three. *Theodor Blum,* D.D.S., M.D. (Penn.), Universae Medicinae Doctor (Vienna), F.A.C.D., F.A.C.S. 337

International Association for Dental Research. Scientific proceedings of the Eighth General Meeting, Toronto, Canada, March 24–26, 1930. Compiled by *William J. Gies,* F.A.C.D., *Secretary* 367

WAVERLY PRESS, INC.

BALTIMORE, U. S. A.